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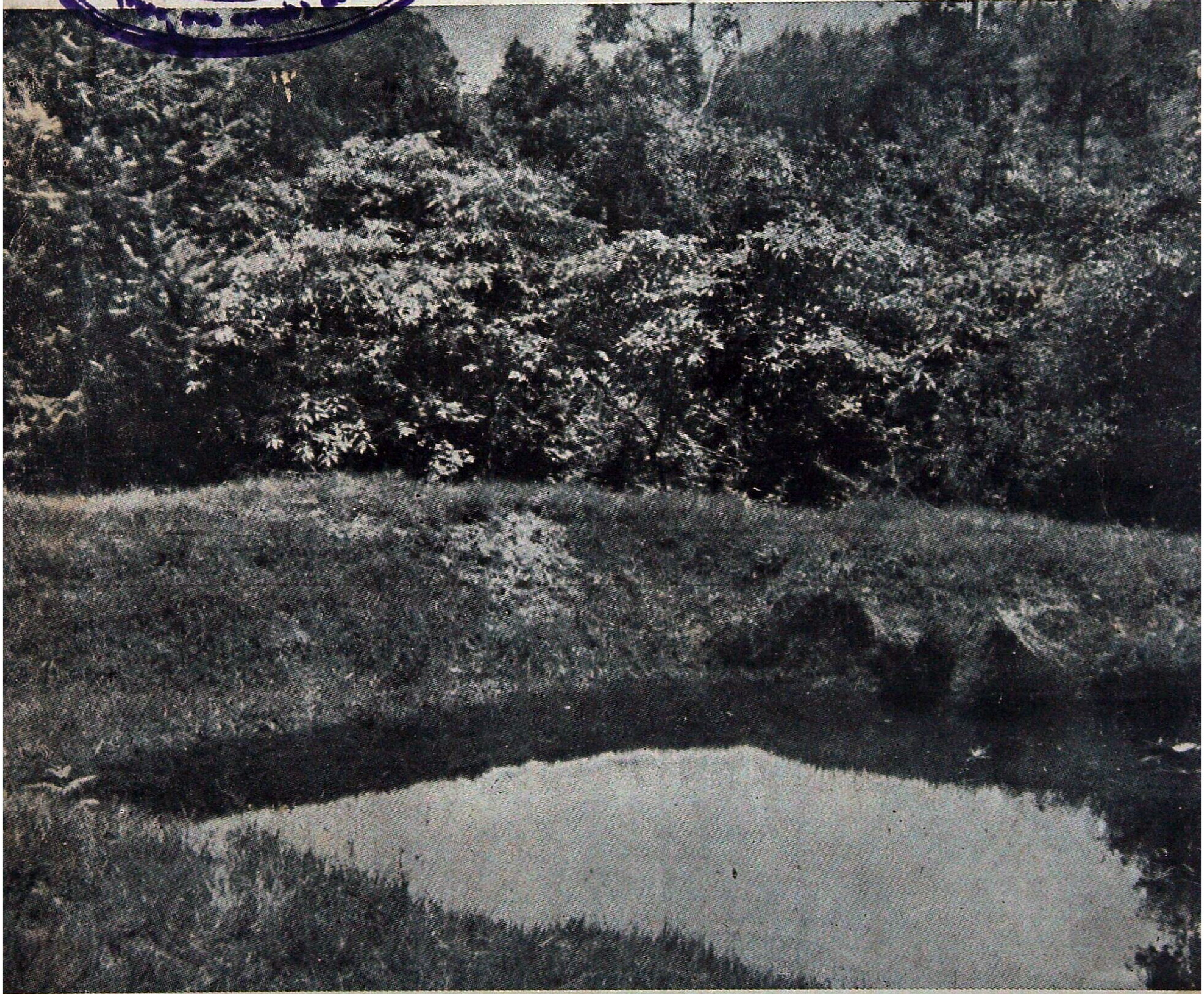

Volume 114 AUGUST 1988 No. 8

Telegram Indian Forester Telephone : 27021/264

INDIAN FORESTER

(A Monthly Journal of Forestry and Forestry Research)

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VOLUME 114 NUMBER 8

THE
INDIAN FORESTER
AUGUST, 1988

COMPARATIVE ANALYSIS OF THE PERFORMANCE OF SEEDLINGS OF SOME FOREST TREE SPECIES UNDER THE INFLUENCE OF FERTILISERS. I—FIELD CONDITIONS

T.P. SINGH* AND G.S. PALIWAL**

Introduction

The Forest Department of Uttar Pradesh is vigorously engaged in afforesting the degraded Civil and Soyam lands in the hills. The area to be planted is fenced by means of a stone rubble wall. Owing to steep gradients over which these walls run, gravitational forces and the lack of binding material result in severe damage to them which result in their breakdown by the third or the fourth year, or even earlier, leaving the young plantation unprotected. In this context, it is felt that the use of optimum amount of fertilisers and manures can be instrumental in enhancing the height of the plants to a level where they cannot be damaged by browsing and this would be a major step towards ensuring successful plantations.

The accelerated growth rate due to the use of fertilisers also solves the weeding problem to some extent. The young plants can cross the stage of suppression by weeds within one year by the use of fertilisers and manures as has been proved for teak (NCA, 1976).

Most of the hilly areas are in bad shape because of lack of proper scientific management of the available land The soil depth is very low and due to lack of any vegetational cover, whatever little soil is present, it is devoid of any nutrients. Obviously, addition of fertiliser and manures are a must in these regions if the plants are to survive on such exhausted soils.

Aims and scope of the present study

Over the past couple of decades, has been a growing realization that the forest tree nutrition can play an important role in augmenting the production of wood and related products. This has become even more important with the introduction of fast growing exotic species and plantation

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forestry programmes, particularly the monoculture which has brought into prominence the utility of nutrient and fertiliser application for maximising wood production coupled with the idea to keep and maintain the site in a highly productive state.

It is no denial that the nutritional requirements for the species of our country is still either not available at all or we have only very limited information from such a standpoint.

In this context, it has been repeatedly felt that efforts are immediately needed to carry out field trials wherein the growth performance of the seedlings could be judged under the influences of variable dosages of fertilisers having different composition. The present study which attempts at examining seven speciesis a beginning in this direction.

It must be remembered, however, that the establishment of seedlings alone is not enough. What we need is their survival, speedy growth and transformation into healthy, mature trees. We are convinced that such attempts although still at their infancy, would be multiplied over the years and more and more species will be covered under the gamut of such an analysis.

Materials and Methods

Research Site : The experiments were conducted at a site near Jeti village. It is located at a walking distance of about 2 kms on the Nandprayag-Karnaprayag motor road, 8 km from Nandprayag and at an elevation of about 1,200 m Two adjacent plots were demarcated in this region, each measuring about 3,000 m^2, corresponding to the two random designs of planting adopted.

Configuration of the ground, Geology, Rock and Soil : The experimental plots are located in the Alaknanda valley on the ridge which forms the watershed of Pindar and Mandakini river. The slopes are generally very steep to precipitous and the entire region presents a highly rugged overall picture.

The rock type exposed in this region is that of the "Garhwal group". These consist mainly of quartzite and associated basic metavolcanics, schists, phyllite, and the dolomite limestone, slate and phyllite of the Calc zone of Pipalkoti. It is intruded by basic and acidic rocks, occurring as dolerite metadolerite and granite gneiss, respectively.

Areas occupied by gneiss present a mixture of light-coloured sand and micaceous soil, whereas the phyllite yields clayey, and at places even dark grey soil.

Meteorological data : A maximum-minimum mercury thermometer was installed adjacent to the experimental site and daily record of temperature was maintained for a period of one year. These along with the general metereological chart of this region have been depicted in Table 1.

Soil analysis : Soil was collected at three points of the profile-surface, at depths of 30 cm and 45 cm, mixed throughly and then chemically analysed. This procedure was followed for both sites.

Table 1

Statement of the climatic data at the plantation site

Month and Year		Plantation Site-Jeti			
		Temperature		Total rainfall	% relative humidity
		Maximum (°C)	Minimum (°C)		
August	1982	32.29	23.34	72.37	67
September	1982	32.23	22.00	72.37	67
October	1982	31.97	14.74	49.35	74
November	1982	28.50	12.33	06.75	71
December	1982	23.90	7.81	06.75	59
January	1983	21.39	6.90	0.00	57
February	1983	22.25	8.11	0.00	61
March	1983	24.16	11.97	41.25	67
April	1983	27.63	14.93	54.00	57
May	1983	33.39	19.29	73.12	75
June	1983	36.47	21.40	93.60	69
July	1983	33.77	23.42	229.00	96
August	1983	35.45	23.84	127.87	90

The results of such an analysis of the soil from the two sites are given below :

Constituents	*Site 1*	*Site 2*
(i) pH	5.5	5.9
(ii) Organic Carbon %	0.675	1.125
(iii) Available phosphate kg/ha	19	11
(iv) Available potash kg/ha	35	78

ging of pits : Pits measuring ×45 × 45 cm were dug at a distance of 2 m each in a staggered formation. operation was carried out in the month bruary, 1982 so that the soil gets ered by the time planting work is taken.

Random design of planting : A random design of planting for the two plots was derived by codifying the plant species, the treatment and the replicates, with the help of a computer. Thus each species was allotted a specific code number as indicated below :

Species	*Code No.*
(i) *Albizia odoratissima*	1
(ii) *Celtis australis*	2
(iii) *Grewia oppositifolia*	3
(iv) *Juglans regia*	4
(v) *Morus alba*	5
(vi) *Sapindus mukorossi*	6
(vii) *Toona ciliata*	7

Similarly, each of the seven fertiliser treatments (along with the control) were codified as indicated below :

Treatments		Code No.
(i) DAP	100 gm	1
(ii) DAP	150 gm	2
(iii) Potash	80 gm	3
(iv) Potash	120 gm	4
(v) Compost	1000 gm	5
(vi) Compost	1500 gm	6
(vii) Control		7

In total, fifteen replicates of each species were maintained.

In the process of codification, all the above mentioned parameters were grouped together, to form a composite code, which gives the species experimented upon at a glance, its replicate number and the treatment provided; the first digit of the plant code indicating the species, the next two stand for the replicates, and the last denotes the treatment given. For example, the code number 5084 indicates that the species under consideration is *Morus alba*, whose eight replicate is being treated with 120 gm of potash.

Calculation of the fertiliser dose : A dose of 250 kg per hectare of DAP works out to 100 gm per plant (2,500 plants/ha). Similarly, a dose of 375 kg per hectare of the same fertiliser would work out to 150 gm per plant. A dose of 200 kg per hectare of muriate of potash works out to 80 gm per plant and a dose of 300 kg per hectare of the above fertiliser works out to 120 gms per plant. In case of the compost, doses of 2,500 kg per hectare and 3,750 kg per hectare work out to 1000 gm per plant and 1500 gm per plant, respectively.

Planting : Planting operations were carried out in the month of August, 1982 when the monsoon was at its peak. The soil heaped around the pit was pushed back into it after removing all the debris. Healthy nursery seedlings of the desired species were selected from the adjoining nursery and planted in the pits. Naked root planting of all the seven species was undertaken taking care that the planting operations are carried out when the sky was overcast.

Simultaneously, a hole was drilled in the soil filled pit by means of a long iron rod. Gradually the root of the seedling was lowered into this hole and held firmly so that the root remains straight and does not get bent. Additional soil was then heaped into the pit and holding the plant firmly with both the hands, the soil was pressed with feet.

Application of the fertilisers : DAP, the muriate of potash, and compost were applied in various doses as per indications provided by the plant code number of the random design. A circular depression of 15 cm radius was made keeping the stem of the plant as the centre. The desired dose of the fertiliser was then added in this depression (about 2 cm deep) and covered over with a small quantity of soil.

Growth performance : Four parameters were selected to gauge the efficacy of vario doses of different types of fertilisers. Th are :

(i) *Height* : It furnishes an idea of net height increment in succe phases. It was recorded with the of a meter scale from the soil s to the terminal apex. The h

growth was taken to be the base for the purpose of comparison of different parameters and was thus allotted a Significance Value Index of 100 for the purpose of computer analysis.

(ii) *Stem diameter*: Increase in the stem diameter is a direct indication of the cell division and expansion in the tissue in the primary state and after cambial activity. The stem diameter of the plants was recorded with a screw gauge, 5 cm above the soil surface. A significance value of 80 was allotted to this parameter.

(iii) *Leaf length* : This parameter has been studied to understand the influence of different factors on the differentiation of various tissues composing the leaves. The length of the visibly largest leaf was recorded with the help of a graph sheet. A Significance Value of 60 has been allotted to this parameter.

(iv) *Leaf breadth*: This was selected for the same reasons as enumerated for the leaf length. The breadth of the leaf which was selected for measuring the length, was also measured by drawing outline on a sheet of graph paper. This parameter has also been allotted a Significance Value of 60.

Recording of the data: Initial recordings of the data of parameters discussed above, was done immediately after planting and the final in the month of August, 1983, exactly one year after the initiation of the experiment.

Observations

Influence of various fertiliser treatments at Sites 1 & 2: The effect of the application of various fertilisers in different doses was studied for the seven species in respect to the four parameters enumerated above. The results so obtained are summarised in Table 2.

In order to find out the overall best treatment, computations were carried out in accordance with the Significance Value Indices allotted to each parameter. The results of such computations are indicated in Tables 3 & 4 and the best fertiliser treatment for each specie is indicated in in Table 5.

Discussion

It has been observed by research workers all over the world that the initial induced differences in the relative growth rates continue to widen throughout the life of a tree crop and such increases result in a substantial reduction in the length of rotation required to achieve a specified volume (Baule & Fricker, 1970; Waring 1973). Seven species investigated in the present work are widely planted by afforestation workers in the hills. These tend to be slow starters because of the lack of proper nutrients in the eroded hills. The present investigation was, therefore, chiefly aimed at overcoming this impediment by the use of appropriate fertilisers and manures. The salient findings of this study based on different responses expressed by the different species, have been discussed below :

Performance of the seven species under different treatments vis-a-vis the control: Rennie (1955) had reported that a well managed forest stand exerts considerable drain on the soil nutrients and the poor

Table

Summary of the influence of various fertilisers on the

Species	Site 1				
	DAP 100 gm	DAP 150 gm	Potash 80 gm	Potash 120 gm	Compost 1000 gm
A. odoratissima	Ht. 86.59 L.B. 107 63	—	—	L.L. 57.75	—
C. australis	L.B. 11.39	L.L. 19.83	—	—	—
G. oppositifolia	—	—	L.B. 19.73	—	S.D. 85.38
J. regia	—	—	L.B. 46.79	L.L. 25.57	—
M. alba	L.L. 47.28	—	L.B. 32.58	—	Ht. 77.54 S.D. 77.43
S. mukorossi		Ht. 64.12 S.D. 49.79	—	L.L. 32.04 L.B. 38.78	—
T. ciliata	L.L. 42.25	Ht. 71.95 S D. 88.10	L.B. 55.25	—	—

Ht.=Height; S.D.=Stem diameter; L.L.=Leaf length; L.B.=Leaf Breadth.

sites are usually unable to meet this demand. This study has definitely removed the myth that the nutrient requirement of the forests is negligible and has lent credence to an established fact that the addition of fertilisers and manures leads to a substantial increase in the tree growth (Bhatnagar, 1966).

As is evident from the analysis of the soil samples from the two sites, Site 1 is poor in nitrogen and potash and possesses more phosphorus as compared to Site 2, which has a higher quantity of nitrogen and potash and less of phosphorus. Also the former is more acidic in nature than the latter. In other words, it means that Site 2 is slightly better off than Site 1 as far as the nutrient status is concerned. This vital observation has to be kept in mind while discussing the growth responses due to various treatments.

All the growth parameters investigated for gauging the efficacy of different fertiliser treatments have responded positively when compared to the control.

2

growth performance of the species investigated at Sites 1 & 2

	Site 2					
Compost 1500 gm	DAP 100 gm	DAP 150 gm	Potash 80 gm	Potash 120 gm	Compost 1000 gm	Compost 1500 gm
S.D. 51.72	Ht. 86.28 L.B. 88.71	L.L. 58.03	—	—	S.D. 60.52	—
Ht. 64.76 S.D. 60.80	—	L.B. 15.20	—	—	Ht. 63.64 S.D. 56.34 L.L. 21.63	—
Ht. 88.05 L.L. 24.24	L.L. 26.85	—	—	—	Ht. 78.40	S.D. 64.05 L.B. 32.21
Ht. 24.07 S.D. 53.39	—	S.D. 44.83	L.L. 32.76	L.B. 21.12	—	Ht. 30.00
—	—	Ht. 112.32 S.D. 59.10	L.L. 44.00	—	—	L.B. 62.82
—	S.D. 48.46 L.B. 51.72	L.L. 22.85	—	Ht. 62.89	—	—
—	—	Ht. 51.10	L.L. 14.23	—	S.D. 65.87 L.B. 44.49	— —

Figures indicate percentage increase over the control.

The deduction of the results obtained clearly reveal that each species has found favour to a specific treatment by showing a better growth performance (Table 5).

A perusal of the findings discussed above indicates that compost has found favour with most of the species studied. This phenomenon can be attributed to the fact that compost has nearly all the major nutrients in its composition.

In general it can be made out that larger quantity of compost per plant and higher doses of DAP treatment were required at Site 1. This can be explained in terms of lower quantity of organic carbon and available potash at this site.

An important aspect of organic manures is that these are slow in acting and the organic nitrogen is transformed into available form very slowly (Sahu, 1970). Thus the nutrients are available to the plant over a larger span of time, which is bene-

Table 3

Influence of various fertiliser treatments on the growth performance of the species investigated in Site 1

Subjects	Significance values per treatment							
	DAP 100 gm	DAP 150 gm	Potash 80 gm	Potash 120 gm	Compost 1000 gm	Compost 1500 gm	Control	Total Significance values
A. odoratissima	218.03	191.13	164.49	205.33	182.60	249.59	96.56	1307.73
C australis	222.83	170.64	140.90	165.38	178.92	218.85	97.46	1194.98
G. oppositifolia	165.52	226.07	202.41	144.02	261.58	292.78	171.81	1464.19
J. regia	148.60	128.14	188.28	162 52	208.03	219.75	91.84	1147.16
M. alba	196.33	216.17	214.69	176.54	254.66	241.32	201 07	1500.78
S. mukorossi	207.82	227.35	206.48	240.49	226.84	169.33	143.49	1421.80
T. ciliata	168.44	251.61	210.68	193.03	175.11	189 36	179.73	1367.96

Table 4

Influence of various fertiliser treatments on the growth performance of the species investigated in Site 2

Species	Significance values per treatment							
	DAP 100 gm	DAP 150 gm	Potash 80 gm	Potash 120 gm	Compost 1000 gm	Compost 1500 gm	Control	Total of Significance values
A. odoratissima	255 64	257.87	164.54	126.70	225.10	187.16	97.14	1314.15
C. australis	196.50	235.44	147.41	182.96	259.42	191.55	91.23	1304.51
G. oppositifolia	247.64	235.75	175.84	167.76	260.40	261.54	138.10	1487.03
J. regia	171.83	145.12	122.81	171.96	210.11	227.24	115.97	1164.84
M. alba	186.41	244.51	204.11	165.91	201.54	269.72	138.61	1410.81
S. mukorossi	252.25	235.61	181.27	252.72	232.45	202.95	138.12	1495.37
T. ciliata	205.55	240.05	191.30	234.12	279.21	188.07	212.52	1550.82

Table 5

Best fertiliser treatment for the species investigated at Sites 1 & 2

Species	Site 1		Site 2	
	Fertiliser treatment	Significance value score for the treatment	Fertiliser treatment	Significance value score for the treatment
A. odoratissima	Compost 1500 gm	249.59	DAP 150 gm	257.87
C. australis	DAP 100 gm	222.83	Compost 1000 gm	259.42
G. oppositifolia	Compost 1500 gm	292.78	Compost 1500 gm	261.54
J. regia	Compost 1500 gm	219.75	Compost 1500 gm	227.24
M. alba	Compost 1000 gm	254.66	Compost 1500 gm	269.72
S. mukorossi	Potash 120 gm	240.09	Potash 120 gm	252.72
T. ciliata	DAP 50 gm	251.61	Compost 1000 gm	279.21

ficial for the overall growth and development of the seedlings. The effect of organic manures on soil productivity may be indirect as well as direct, depending largely on their physical, chemical and biological natures. The direct effects relate to retention and release of plant nutrients (both macro- and micro-) whereas among the most important indirect effects are the microbial fixation of nitrogen and solubility followed by release of phosphorus compounds, in the soil, the slowing down of nitrogen release from added fertilisers, improving physical and biological conditions of the soil, and moisture and ion (both cation and anion) retention capacities.

Next to Compost, DAP treatments have proved to be suitable in some of the species. This is in concurrence with the conclusion of several workers who maintained that phosphorus with nitrogen give better yields and thus is more economical (National Commission on Agriculture, 1976 Report). Further, phosphorus in combination with nitrogen improves the physical condition of the soil thereby contributing to soil and moisture conservation. In addition when nitrogen is added, the metabolic rate of plants is accelerated which accelerates the uptake of not only phosphorus but other minerals required by the plant. It is for this reason, therefore, that the application of nitrogen in combination with phosphorus gave consistently higher yields in natural grasslands in the Ambala Siwaliks (Erasmus & Sud, 1976). The results obtained in this investigation are also a pointer towards this fact and they amply demonstrate that nitrogen in combination with phosphorus is far superior to potash treatment alone or control.

The availability of nitrogen, applied on the surface, to the plant is largely dependent upon rain or irrigation water enabling the nitrogen to move into the root zone. It is, however, believed that there is a significant diffusion of nitrogen even

when moisture is constant and higher the nitrogen concentration, the greater is the diffusion. There is also sufficient conclusive evidence to suggest that weeding and hoeing could help to improve soil aeration and augment the nitrogen uptake (Roy, 1976). Most of the plantations taken up in the hills are unirrigated and dependent upon rains. Thus the results obtained in the field conditions supplement the views expressed above because rain water has proved to be sufficient to move the minerals applied, into the root zone. Furthermore, hoeing and weeding can be carried out to improve the soil aeration thereby further increasing the availablity of minerals in the root zone.

The application of muriate of potash alone resulted in better growth performance of seedlings of only one species *S. mukorossi*, on Site 1 and 2. This phenomenon may be due to unusually higher requirement of potassium by this particular species. It is well known that potassium is necessary for the synthesis of proteins, particularly in the meristems and normal cell division. In the absence of potassium the cells elongate but fail to divide. The forest trees use large amounts of potassium and the ash commonly contains twice as much potassium as phosphorus. About 40% of the total requirement goes into the wood and practically all of the remainder into the foliage, whence it is returned to the soil through leaf-fall (Byers *et al.*, 1938; Lutz & Chandler, 1946).

Comparison of the performance of different species among themselves : Table 3 and 4 indicate the results obtained in terms of Significance Value Indices for Sites 1 and 2, respectively. These reveal that *M. alba* has responded best at Site 1 by securing 1500.78 points and *T. ciliata* at Site 2 with 1550.82 points.

Thus, though all the seven species have shown better growth responses, *M. alba*, *G. oppositifolia* and *S. mukorossi* seedlings have reacted more favourably to fertiliser application followed by *T. ciliata*, *A. odoratissima*, *C. australis* and *J. regia* at Site 1. At Site 2, *T. ciliata*, *S. mukorossi*, *G. oppositifolia* and *M. alba* have proved to be more receptive to the fertilisers provided as compared to the other three species.

Recommendations

It has been shown that nutrition requirements of plants differ from species to species depending upon their ability to derive nutrients from the soil. The physical, chemical and biological reactions between the soil and added fertilisers collectively determine the availability of nutrients and hence the efficiency of fertiliser used (NCA, 1976).

Thus any recommendation as to the fertiliser and its dosage for a particular species will have to take into consideration the soil characteristics of the plantation site.

As regards the present study it is revealed that Site 1 is poorer in nutrients as compared to Site 2. For the purpose of recommendations, the Significance values obtained for each treatment for a species on the two sites have been added together and depicted in Table 6. Based on this the species-wise recommendations of fertilisers and their doses is as follows :

A. odoratissima	:	DAP 100 gm per plant
C. australis	:	Compost 1,000 gm per plant.

G. oppositifolia	:	Compost 1,500 gm per plant.
J. regia	:	Compost 1,500 gm per plant.
M alba	:	Compost 1,500 gm per plant.
S. mukorosi	:	Potash 120 gm per plant.
T. ciliata	:	DAP 150 gm per plant.

Conclusion

From the foregoing discussion it is evident that by the addition of mineral fertilisers and organic manures, a substantial increase in the plant growth and development can be achieved. Hence, there is a tremendous scope for the fertiliser usage in the establishment of new plantations.

Table 6

Influence of various fertilisers based on addition of significance values of Sites 1 & 2

Species	Combined Significance Values per Treatment (Site 1 + Site 2)						
	DAP 100 gm	DAP 150 gm	Potash 80 gm	Potash 120 gm	Compost 1000 gm	Compost 1500 gm	Control
A. odoratissima	473.67	449.00	329.03	332.03	407.70	436.75	193.70
C. australis	419.33	406 08	288 31	348.34	438.34	410.40	188.69
G. oppositifolia	413.16	461.82	378.25	311.78	521.98	554.32	309.91
J. regia	320.43	273.26	311.09	334.28	418.14	446.99	207.81
M. alba	382.74	460.68	418.80	342.45	456.20	511 04	339.68
S. mukorossi	460.07	462.96	387.75	493.21	459.29	372.28	281.61
T. ciliata	373.99	491.66	401.98	427.15	454.32	377.43	392.25

Acknowledgements

It is a privilege to acknowledge with gratitude, the encouragement and assistance that the authors received from Shri R.S. Mathur, I.F.S. who took real pains to plan the various experiments. But for his generosity, we would have hardly been able to initiate this work. The computer analysis was got done through the courtesy of Shri K.S. Mehta of the International Systems Services, Nehru Place, New Delhi, to whom we wish to express our sincere gratitude.

SUMMARY

The present work has been aimed at analysing the growth response of seven indigenous tree species under the various fertiliser treatments in the field conditions. The results obtained have revealed that a marked improvement in growth responses takes place by fertiliser application. However, any recommendation as to the fertiliser and its dosage for a particular species will have to take into consideration soil characteristics of the plantation site. Keeping in view the above limitation, specific recommendations of fertiliser doses have been made for the seven species investigated.

कतिपय वन वृक्ष जातियों के पौधों की उर्वरक उपयोग करने पर क्रियाशीलता का तुलनात्मक विश्लेषण—I. क्षेत्र दशाए

टी०पी० सिंह व जी०एस० पालीवाल

सारांश

प्रस्तुत अध्ययन का उद्देश्यक्षेत्र दशाओं में विभिन्न उर्वरक उपयोग करने पर सात देसी वृक्ष जातियों में हुए वृद्धि प्रतिचार का विश्लेषण करना है। इसके परिणामों ने दिखाया है कि उर्वरक डालने से वृद्धि प्रतिचार में स्पष्ट परिष्कार आता है। परन्तु किसी वृक्ष जाति के लिये कौनसा उर्वरक उपयोग किया जाए, उसकी मात्रा कितनी रखी जाए यह बात निश्चिन करते समय रोपण स्थल की मृदा विशिष्टताओं पर भी ध्यान देना होगा। इन सीमाओं को ध्यान में रखते हुये अन्वेषित की गई इन सात जातियों के लिए उर्वरक की विशिष्ट मात्राएं अनुशासित की गई हैं।

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FOREST BIOMASS—A SOURCE FOR FOOD, FEED AND FUEL

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Introduction

The word biomass generally refers to a renewable resource of plant or animal origin. Forest biomass, in contrast with agricultural or ocean biomass, includes all renewable goods produced in the forests. The more important ones are the principal forest products derived from wood, such as, timber, pulpwood and fuelwood. In addition, wood in other forms (residue from logging and sawmilling operations, such as, branches, tops, dead or diseased trees, sawdust, bark, chips) and leaves constitute a substantial proportion of the potentially usable forest biomass.

Wood, the major constituent of forest biomass, serves as raw material for many industrial products (lumber, pulp & paper and panel products). In this paper, we ignore the contemporary industrial uses of forests and concentrate on some other important features of forest biomass which are generally ignored, or not adequately appreciated, especially by urbanized western societies. The purpose of this paper is to highlight the role of forest biomass as a source for food (for human consumption , feed (for animal consumption) and fuel. A thorough quantitative assessment of this aspect of forest biomass is not possible due to lack of relevant data, especially for food and feed. Nevertheless, an effort has been made to be as objective as possible in dealing with the subject. Emphasis has been laid on the significance of forest biomass in the less developed countries (LDC's), though wherever necessary, its role in the world as a whole, or in the developed countries, is also presented.

Ancient societies lived in the forest and were entirely dependent on it for their survival. Even today, rural societies in the developing countries utilize large volumes of forest biomass for their day to day needs. For them firewood is often the only fuel for cooking and heating, forest lands provide fodder for their cattle, and they frequently hunt wild animals for food. Two factors in recent years have focussed attention on the need to take stock of the availability and potential utilization of forest biomass. First, the population explosion, and second, the realization that fossil fuels, the most convenient and popular sources of energy these days will be exhausted in the near future.

Unfortunately, a clear picture of the dependence of the people of the developing countries on forest biomass cannot be seen.

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Unlike industrial products, no statistical records of production and consumption of such products as, fuelwood, grasses, or wild animals are kept. These goods are not generally traded and their conversion and utilization involves only "household activity" of national accounting systems. As they do not pass through the market system, no statistical record of their production and consumption is usually kept. Even when some scanty account of these activities is available, it is grossly underestimated because much of the forest use, such as fuelwood collection, grazing and hunting is "illegal" from the points of view of governments who are loath to admit such irregularities in their jurisdictions (Openshaw, 1978). The fact that commodities not passing through the market system are not included in the calculation of gross domestic product undervalues the actual role played by forestry sector in the economic growth of a developing country (Earl, 1975).

Forest Biomass as Food

Food is the basic necessity of every human being. Forest biomass can supply food either as a vegetable product (e.g., cereals, fruits, nuts, leaves, or roots) or as an animal product (e.g., meat, fish or honey). Development of agriculture, means of transportation and markets have, over the period, reduced the role of forest as a provider of food. To the western societies perhaps, food may appear to be an insignificant constituent of forest biomass, but it must be remembered that all the common staples today are in fact improved and hybridized forms of, once wild food (Coon, 1974).

It is common knowledge that until the time man settled in civilized societies and began growing his own food, he depended on the forests for all his nourishment. We have evidence from the recent past how the native Indians of the American continents (Coon, 1974) and the aborigines of Australia (Cribb & Cribb, 1974) lived in their natural surroundings. Even today there are several rural communities, losely called as 'nomads' or 'tribals', especially in the developing countries who, to a large extent, still depend on forests for food. Some examples of these tribes are such hunter groups as 'Sloubba' of Arabian desert, 'Nemadi' of Mauritania, 'Kalahari Bushman' of South-west African desert, 'Vedda' of Sri Lanka, 'Dorobo' of East Africa and 'Chaco' of Tropical America (UNESCO, 1979).

As far as production of vegetative food collected from the forests is concerned, perhaps there are no statistical records available as to the quantity consumed or the size of the population benefitting from it. Usually all the literature on this subject is confined to listing of hundreds, and even thousands, of species of wild, but edible, plants growing in the different parts of the world (e.g., see Fernald & Kinsey, 1943; Medsger, 1957; FRI, 1972; Coon, 1974; Cribb & Cribb, 1974). However, in the case of game meat, some quantitative information is available for certain African and Latin American countries (De Vos, 1978; UNESCO, 1979).

De Vos (1978) has reported several studies which reveal that game meat constituent of forest biomass is very important source of food for a large number of people in the developing countries. For instance, in some parts of Ghana, 73 per cent of

locally produced meat might come from wild animals; the estimated composition of game meat in Botswana was 60 per cent per person per annum; in the northern parts of Ivory Coast, daily per capita consumption of 'bushmeat' (i.e., all foods obtained by hunting or trapping) was 27 grams; 75 per cent of animal protein in Zaire came from wild sources; in Nigeria, 19 per cent of the locally produced food for the year 1965/66 was game consumed in rural areas; in Ucayli region of Amazon, fish and wildlife accounted for about 85 per cent of animal protein consumed by the people in rural areas. These figures indicate that in several regions, domestic livestock have been unable to cope with the ever increasing demand for meat, and forest biomass has played a considerable role in making up the shortage. (In the earlier stages of civilization, it might have been the shortage of wild meat which led people to raise domestic livestock).

Wild food is seen as a by-product of forestry, but there is no reason why in certain regions some part of the forest may not be managed specifically for its production. If a forest is well managed, it can yield a forest biomass, balanced in both wood and food. The tropical mixed forests growing in most of the LDC's are suitable for multiple use forest management.

Besides appropriate forest management, educating and informing people about forest biomass as an alternate source of food is important.

A greater interest in wild foods can lead to their better utilization and higher level of research in them. This could be very useful in developing new sources of food from forest biomass. For instance, marsh-marigold, the docks and dandelion were considered worthless weeds only a few decades before they became common food plants (Fernald & Kinsey, 1943). Tree foliage, generally used as nothing more than fodder for animals, has varying concentrations of protein, and an acre of forest may contain 1 to 3 tonnes of protein that can be processed into useful foods for human consumption (Pirie, 1968). Though food value of forest biomass cannot solve the global food problem, in many parts of the world the potential of wild food and food extractants from forest biomass for contributing to improvement in people's standards of living is much greater than is appreciated by the Governments and specialists concerned with food and nutrition. More attention should be paid to develop these unconventional foods in the forest and the methods of their collection.

Forest Biomass as Feed

Wild animals are dependent on forest habitat for their survival and they generally get all their food from the forest boimass. In addition, forests provide feed for domestic animals which play a crucial role in the rural economies of developing countries

Raising of domestic livestock for the production of meat, milk and wool is an important commercial activity in the developed countries. In the developing countries, however, there is a much higher degree of dependence of man on animals since, in addition, they provide several other goods and services, such as traction, skin, dung for fertilizer and fuel, insurance against drought and crop failure, and prestige and

other cultural needs (McDowell, 1980). In the dry regions of the earth, which constitute about 35 per cent of land containing 500 to 600 million people, some 30 to 40 million people have animal based economies (Sandford, 1983). 'Beduins' of West Asia, 'Nilo-Hamites' of East African steppes and 'Gujars' of North Indian hills are some of the well known communities entirely dependent on livestock and hence pastures and forest lands, for their survival (UNESCO, 1979).

Over 50 per cent of the world livestock population lives in the less developed Afro-Asian countries (FAO, 1985a). Sufficiency in food production for human beings is the most pressing problem of these countries, and they cannot afford to grow grain for the cattle there. Therefore, in these regions, forest biomass (grasses, shrubs and fodder trees) is an important source of cattle feed. According to Pirie (1968), "trees and bushes probably supply more fodder for the world's population of ruminants than is supplied by the grasses".

The actual number of cattle dependent on forest biomass for feed is difficult to ascertain accurately. However, an illustration will give the general idea In India, on the basis of the number of grazing permits issued, about 12 per cent of the total cattle population obtained grazing in the forests during the mid-sixties (FRI, 1972). Actual proportion is, however, likely to have been much higher because the number of grazing permits usually depends on the carrying capacity of the forest area (that remains almost constant) which is generally much less than the ever increasing livestock population in the vicinity of the forests, and the consequent illegal grazing is quite common. Even assuming that 15 to 20 per cent of Indian livestock graze in the forests is saying a lot when we consider the fact that India contains more than one sixth of the world's livestock (FAO, 1985a).

In comparison with grasslands, the per hectare production of forage grasses in the forests is clearly low, and the denser the forest canopy the lower the grass productivity. However, the tree cover in the forests influences the environment and forest soil in ways which favour germination of herbaceous species that are often preferred by livestock (UNESCO, 1979). Even certain unpalatable weeds or grasses such as *Saccharum munja* can be added to cattle feed after treatment (Vasudevan *et al.*, 1984). Besides grasses, forests provide shrubs and fodder trees which serve as cattle feed and are favoured food for certain browsers, such as goats and camels (Singh, 1982). The leaves, twigs and pods of the fodder trees are lopped and fed directly, or mixed with hay or grasses, to the cattle, especially, during the season when the forage grasses become less palatable (FRI, 1972). In case of trees such as hybrid poplars which have low fodder value but produce profuse foliage, the leaves can be processed and their protein concentrate and residue can be used as feed for poultry and ruminants, respectively (Chen, 1979).

The role of forest biomass as animal feed is seen as adversely affecting its major role as timber supplier. Grazing destroys seedlings of valuable species and damages the soil by trampling Lopping devastates the trees and disfigures the whole forest. Graziers often set fires to the grasses in the hope of getting a better forage in the

following season which sometimes destroys the whole forest. But, a summary ban on grazing through legislation and strict enforcement of rules by forest departments may not be successful as it would clash with the people's rights and hence create political problems (Tucker, 1984). In many hill regions there is little grazing land available and fodder from the forest is the only source of feed. At least in the case of the Himalayas one can perhaps claim that without tree fodder, mostly from Oak (*Quercus* spp.), there might be no cattle or human population in the region in the long-run because except for the area above tree line, forest, and not grassland, is the climax vegetation in the region (Jackson, 1983).

However, it is only over-grazing, heavy lopping or unscientific forest management that creates problems. Controlled grazing, on the other hand, may help the forest environment favourably by eliminating useless species and by reducing fire hazard by keeping the ground flora clear of inflamable grasses (Trotter, 1940). Lopping can be controlled by specifying what species can be lopped, upto what height and during which season. Cultivation and protection of useful fodder species such as *Acacia* spp, *Quercus* spp. and *Leucaena leucocephala* will help increase fodder production. Controlled burning can be used not only to get a better growth of grasses but also to pre-empt any accidental forest fires. Introduction of stall-feeding can diminish the problem of over-grazing with an added advantage of increasing the amount of dung collected for farm manure (Nautiyal & Babor, 1985). Thus, if grazing and lopping are scientifically managed and carefully controlled, forest biomass can achieve an economic value higher than that from being a mere supplier of wood.

Forest Biomass as Fuel

Forest biomass is mankind's oldest energy source and had fuelled the world's economy for thousands of years before the advent of fossil fuels. The steep increase in the prices of oil and gas, and the realization that fossil fuel era is short-lived has led to the recognition of wood as an important alternative energy option in the developed countries just as it has continued to be in the under developed countries (Lewis, 1981). Though a considerable amount of wood reaching urban centers comes from farmlands (Morgan & Moss, 1985), forests and woodlots remain the principal suppliers. The role forest biomass plays or can play in the world today can be judged from the actual and potential contribution it makes or can make in the socio-economic development of different countries.

According to statistical records of FAO (1985b) fuelwood and charcoal form nearly one-third of the world's annual wood consumption. But, perhaps, the actual utilization is close to half of the total wood harvested in the world today (White & Plaskett, 1981), and it is largely used for cooking and heating by more than half of the world's population (Hall *et al.*, 1982). For the LDC's alone, Openshaw (1978), on the basis of sample surveys of household and non-household consumers, estimated that 82 per cent of the wood harvested was consumed as fuel. The records of FAO (1985b), however, showed the figure to be about 45 per cent.

Though, of the world's total recorded

energy consumption during 1970-78, the share of biomass as a whole (including agricultural and animal wastes, in addition to wood which by far is the dominant component) was estimated to be about 14 per cent (Hall *et al.*, 1982), for many countries forest biomass is the main supplier of their energy needs. For example, forest biomass is the source for more than 90 per cent of all energy for countries such as Ethiopia, Mali, Nepal, Nigeria, Rwanda, Somalia, Tanzania, and Upper Volta, while countries such as Congo, Gambia, Ghana, Guinea, Kenya, Madagascar, Malawi, Niger, Sierra Leone and Sudan depend on forests for 75-90 per cent of their total energy consumption (Hall *et al.*, 1982).

Several new approaches have been developed during the last few decades for deriving energy from wood, such as conversion to wood alcohol (methanol and ethanol) or biogas (methane). There has been considerable progress in the technical aspects of converting wood into energy through these uncoventional means, however, their productivity and economics are still not attractive enough for universal use (Hall, 1982; Jones & Semran, 1984; Shiralipour & Smith, 1984). Understandably, bulk of energy-use today still occurs in the form of traditional fuels, i.e., direct combustion of wood and charcoal.

The use of forest biomass for energy has several advantages over other conventional fuels. It is a renewable source of energy, available in almost all the inhabited parts of the world; whereas fossil fuels, the principal sources of energy in the world today, are unevenly distributed and non-renewable, with their reserves depleting at an alarming rate. Moreover, wood combustion is relatively pollution free as it produces very low amounts of harmful oxides of sulphur and nitrogen (Trimble & Van Hook, 1984). The ash generated is rich in organic matter and can be a useful agricultural soil additive. Reserves of fissioning Uranium, source af nuclear energy, are also finite, and their radioactive wastes pose an immense environmental hazard. Hydro-electricity is a clean renewable source of power, but its developm nt is highly capital intensive and requires a long gestation period.

Thus, development of forest biomass as an alternative source of energy especially in the developing countries, is not only important but also quite urgent. Earl (1975) demonstrated that a nation's GNP was directly correlated with its energy consumption, and therefore, the LDC's are expected to need large amounts of energy for their development. If they do not harness the domestic energy sources, they will be in a greater debt of fossil fuel exporting or aid giving countries. Therefore, they must formulate a comprehensive energy policy which may suit their short-term and long-term requirements. A country may give a lower or a higher priority to the development of forest biomass for energy, depending upon the alternatives available, but it is certain that the task cannot be ignored. This can be stated emphatically because besides being the cheapest fuel available, forest biomass is crucial to the rural economies of these countries (Arnold, 1979). Devastation of forests in the vicinity of villages and densely populated urban areas brings this point home rather dramatically (Morgan & Moss, 1985). Ecological damage and desertification of productive lands will continue if timely

measures are not taken.

Besides supplying much wanted fuel and improving the general environment, the development of forest biomass as an energy source can yield several indirect benefits. Forest development activities, being labour intensive, can provide employment to large numbers, especially in the rural sector (Westoby, 1963).

The beneficiaries often are the poorest of the poor who otherwise drift towards the cities and escalate the problems of urban overcrowing. Moreover, assured supply of fuel can help support and develop rural industries, such as charcoal manufacturing, tobacco curing, brick making, brewing, potteries, rubber manufacturing, sugar production, metal extraction, blacksmithy etc.

A clear understanding of the fundamental problems posed in energy supply and arriving at effective solutions is crucial for the overall development process. The energy question may be directly related to environmental issues in some areas such as the Himalayas (Nautiyal & Babor, 1985). Therefore, formulating an appropriate policy towards forest biomass energy is not an easy task and will require imagination, innovation and a high level of commitment from the concerned country. There cannot be a universal approach to the development of forest biomass for energy purposes. For instance, huge energy farms of 20-25 thousand hectares may be suited for the U.S. (Cheremisinoff, 1980), but may not be workable in a rural area characterized by limited land resources and seasonal unemployment. Complex linkages between humans, livestock, lands, energy and water within each village or township and underlying politico-economic structure may have to be understood before suggesting any treatment to a region (Reddy, 1981).

However, it is not the dearth of suitable schemes to develop biomass fuel but their implementations that often raise biggest problems. The record of several countries where projects aimed at developing forests for energy have been undertaken has on the whole been only modest (Hall *et al.*, 1982). For success in this endeavour, the concerned nations will have to take several steps in a well coordinated manner, such as :

—supplementing natural forest resource by practising agro-forestry or by raising small/medium scale energy plantations near urban centres;

—making fuel more efficient by converting it into charcoal and, where possible, ethanol or biogas;

—densifying forest residues for their easier and more economic transportation;

—improving designs of ovens and stoves so as to make them more energy efficient;

—involving rural women in decision making since they represent the most important section of the population which is directly concerned with fuelwood collection and utilization.

Concluding comments

The role of forest biomass as a supplier of food, feed and fuel was discussed in this paper. Though, presently, there is a lot of interest in forest biomass as a source of fuel and energy and extensive research is

going on in this area, its food and feed aspects are still largely ignored by researchers. This is evident from the lack of attention given to these subjects in scientific journals dealing with biomass or forest resources.

The development of some or all aspects of forest biomass will depend upon the overall policy framework of a country and the relative importance of forest biomass to the national and regional economies. But no development is possible without adequate information on production, consumption and potential of food, feed and fuel related products of the forest resources. Therefore, the first task for governments and decision makers, especially in countries with a large rural population, is to monitor inventories of forest biomass resources to know the current and potential production (Cunia, 1983), and conduct detailed household surveys to estimate demand. With this information it will be possible to know quantitatively the contribution of forest biomass products to national and regional economies. This could provide guidelines for making investment decisions and identify resources requiring development.

The projects for forest biomass resource development should be comprehensive enough to consider not only major outputs such as timber, but should also give due weight to their socio-economic role as provider of food, feed and fuel to the populations living in the vicinity of the forests. Forest development or management should not necessarily mean replacing old forest with plantation of fast growing species. Timber growth in a forest may be slow but its under-storey may be producing large amounts of food and fodder. Local population dependent on these forests may have a different appreciation for these products than an outsider. They might put a greater emphasis on income distribution aspect of a developmental project than on income generation (Douglas, 1982). Therefore, the local community must be involved in the decision making process and its implementation.

Land-use pattern in the LDC's has been changing in favour of agriculture for food production. However, potential for further agriculture development is tremendous For instance, some studies claim that India's maximum food production can reach 30 times her 1980 production level (Miljan, 1980). Even a modest success in the control of population growth and the continuing progress in the per hectare yield of the agricultural sector might, in the near future, make some marginal agricultural lands available for forest biomass production.

These development activities must be accompanied with improvement in transportation and infrastructure, extension activities and education of the people, and continuing research and development in the methods of production and utilization of these resources. Some of these activities can be highlighted as follows :

—developing markets for wild food, meat, fodder and grasses so that there is visible demand and consumption, and hence a greater appreciation, for these products;

—directing efforts towards improving 'country methods rather than introducing expensive modern machines;

—connecting rural industries to markets and consumption centres;

— developing good relations with local groups to win their trust and support;

—educating and persuading local people as to the benefits of new technology (e.g., improved stoves, rotational grazing, food and meat preservation etc.);

—encouraging feedback from users, especially rural women, and involving them directly or indirectly in decision making process.

An integrated approach at the lower level and a political will and commitment at the higher level are essential ingredients in a concerted effort to develop a renewable resource like forest biomass. Improvement in production techniques, forest management and utilization efficiency will take us a long way towards achieving true potentialities of forest biomass in raising the general standards of living, especially in the rural communities of the developing world.

SUMMARY

Role of forest biomass as a source for food, feed and fuel is discussed. Its importance to life and economy of a large number of traditionl societies, especially in the less developed countries, is highlighted. Relevant facts and statistical information are presented. It is suggested that in order to achieve true socio-economic potentialities of forest biomass resources, a national commitment to their development is essential. It is imperative that inventories and demand for forest biomass are monitored; local communities are involved in decision making; production techniques, forest managment practices and utilization efficiency are improved; and extension activities and research and development facilities are strengthened.

वन जैवपुंज—भोजन, चारे और ईंधन का स्रोत

जे०के० रावत व जे०सी० नौटियाल

सारांश

इस अभिपत्र में भोजन, चारे और ईंधन के स्रोत रूप में जैवपुंज की भूमिका का विवेचन किया गया है। पारस्परिक समाजों, विशेषकर अल्प विकसित देशों में, अधिकांश जनों के जीवन और अर्थ व्यवस्था में इसके महत्व पर प्रकाश डाला गया है। संगत तथ्य और सांख्यिकीय जानकारी दी गई है। इसमें यह सुझाया गया है कि वन जैवपुंज ससाधनों की वास्तविक समाजार्थिक संभावनाओं को प्राप्त करने के लिये उनके विकास के लिये राष्ट्र का प्रतिबद्ध होना अनिवार्य है। यह आवश्यक है कि वन जैवपुंज की तालिका और उन पर होने वाली मांग की जांच-पड़ताल रखी जाए, निर्णय लेने में स्थानीय समुदायों को साथ लिया जाये, उत्पादन प्रविधियों, वन प्रबन्ध प्रणालियों और उपयोजन दक्षता में सुधार किया जाए तथा विस्तार कार्यों और अनुसन्धान व विकास सुविधाओं को मजबूत बनाया जाए।

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STUDIES ON NURSERY TECHNIQUES (METHOD OF SOWING AND OPTIMUM DEPTH OF SOWING) OF *AZADIRACHTA INDICA* ADR. JUSS UNDER NORTH INDIAN MOIST TROPICAL CLIMATIC CONDITIONS

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Introduction

Azadirachta indica Adr. Juss *Melia indica, Brandis melia azadirachta* Linn. is a medium sized tree often described as evergreen but in drier areas it becomes deciduous. The tree grows wild in the drier forests of the Deccan. It is a very useful avenue tree planted along road side in drier climate, thriving as a rule where the normal rainfall varies from 45 cm to 115 cm and maximum shade temperature may be as high as 49°C. It thrives better than most other species on dry stony shallow soil with a waterless sub-soil or in places where there is hard calcareous or clay pan not far from the surface. It is well suited for afforestation in dry situations, and hence a promising species for social forestry and wasteland afforestation. The panicles of small white flowers smelling of honey, appear from March-May, and the fruits ripen during June-August. They are greenish yellow in colour when ripe and usually contain only one seed. The seed is a short lived and does not retain its viability long (Troup, 1921). Loss of viability appears due to and is certainly accompanied by the fermentation of the unopened cotyledons inside the inner seed case. If the cotyledons are green, the seed is good and will germinate, but if they have turned brown or yellowish, it is not likely to germinate (Smith, 1939). Neem seeds do not require any special pretreatment but should be sown fresh. Experiments carried out at Forest Research Institute, Dehra Dun indicate that depulping and cleaning the seed considerably improves the germination per cent. Prasad (1941). On the basis of the experiment conducted at F.R.I., Dehra Dun have shown that neem seedlings were severely damaged by 'frost' and 'weeds'. Direct fowing was found to be better than transplanting the seedlings (Troup, 1921).

Neem is multipurpose tree species. Every parts of the neem tree has found application in indigenous medicines. The seed oil of neem is used in skin diseases and cosmetics and oil cake is used as fertilizer (Anon, 1948). Since the tree is of considerable importance in the tropics, an experiment was taken up to determine the best combination of method of seed sowing and optimum depth of sowing at nursery stages and requirement of quantity of seeds for afforestation purposes.

Materials and Methods

The investigations on *Azadirachta*

indica were carried out during the period from 5.8.86 to 30.9.86 at New Forest, Dehra Dun. Seeds were collected from adjoining areas of Saharanpur districts in the last week of July 1986. All beds were prepared well before sowing the seeds. The size of nursery beds was 5 m × 1 m dimensions raised upto 20 cms from ground level, and were provided with bamboos support on both sides of the beds to prevent washing out of the soil. Each bed was kept free from weeds, 0.12 m^3 of well decomposed farm yard manure and washed river sand in equal proportion were added in each bed and thoroughly mixed. In frosty localities, the plants will have to be protected by means of screens.

Design : Randomized complete block design with four replications was adopted. The seeds were sown in 36 raised beds of size 5 m × 1 m and 20 cm high from ground level.

Treatments : There were three treatments of methods of sowing viz. broadcast sowing (T_1), dibbling (T_2) and line sowing (T_3) and three depth of sowing viz. 2.5 cms (S_1) 3.5 cm (S_2) and 4.5 cm (S_3).

In broadcast sowing seeds were scattered over the nursery beds and a layer of mixture of soil, sand and FYM, in 2 : 1 : 1 proportion respectively was spread over the beds to cover the seed properly to a depth as per prescribed depths. In dibbling method, the seeds were sown by making holes with the help of the stick marked with 2.5 cms, 3.5 cms and 4.5 cms and then seeds were inserted into the holes and covered with soil and sand mixture properly. In line sowing, lines were prepared to the depths as per treatments of depth and seeds were sown in these lines and covered with the mixture of soil, sand and F.Y.M.

Seed quantity : Equal quantity of seeds i e. 150 gms was used for each bed. There were 500 seeds in 150 gms of seeds. Seeds per kilogram for this species after actual counting comes to 3,330 seeds. After sowing the seeds, watering was done as and when required and the beds were kept free from weeds.

Observations on number of seeds germinated were recorded everyday in each bed till the completion of the germination. During the germination period the mortality of the seedlings was also recorded every day and dead seedlings were immediately removed from each bed. The germination was completed within three weeks (21 days). After completion of germination data were collected on the number of healthy seedlings available in each bed.

Results and Discussion

Statistical analysis was carried out to see whether any significant difference exists in the effect of treatments on each of the character separately. For the characters, total germination and plant percentage, the data has been converted to angular values ($\text{Sin}^{-1}\sqrt{P}$) and then analysed. The results of the analysis are shown in the table giving mean values under various treatments, level of significance of difference between them and bar diagrams. The results indicate that treatments reveal highly significant difference among themselves giving their effect on each character.

Table

Showing the mean values for the treatments, their significance and bar diagrams for different characters separately

Characters Y		Treatment									Significance
Comencement of germination	Mean	T_3 11	T_6 11	T_{10} 10	T_9 9	T_2 9	T_5 9	T_4 8	T_7 8	T_1 7	***
Emergence Energy value	Mean	T_1 2.69	T_8 2.65	T_7 2.59	T_2 2.29	T_3 2.25	T_9 2.21	T_4 1.50	T_5 1.50	T_6 1.12	***
Total germination per cent	Mean	T_7 48.45	T_8 46.50	T_1 46.55	T_6 46.00	T_2 45.65	T_9 45 50	T_4 31.15	T_5 30 95	T_6 23.80	***
Number of seedlings obtained	Mean	T_7 233	T_1 228	T_8 222	T_9 217	T_2 216	T_3 214	T_5 146	T_4 145	T_6 109	***
Plant per cent	Mean	T_7 46.55	T_1 45.50	T_8 44 80	T_9 43.35	T_2 43.20	T_3 42.75	T_5 29.10	T_4 29.00	T_6 21.85	***

Where T_1, T_2..............T_9 represent the treatments
T_1S_1, T_1S_2, T_1S_3, T_2S_1, T_2S_2, T_2S_3, T_3S_1, T_3S_2 and T_3S_3 respectively.
1 2 3 4 5 6 7 8 9

*** indicate significant at 0.1% level of probability.

Time taken for germination : It is evident from the table that there is significant difference between various treatments. Treatments T_1, T_2, T_4, T_5, T_7 and T_9 gaves similar results and the best results were given by T_1 (T_1S_1) i.e. the germination commenced after 7 days. Thus the seed sown at 2.5 cms depth germinated easily as compared to those sown at 3 5 and 4.5 cms depth, as the time taken in these cases was 10 and 11 days. However, all the combination of sowing methods with 2.5 cms depth gave similar results.

Total germination per cent : The results indicate highly significant differences among various treatments. The values are higher in those cases where the depth of sowing is less i.e. 2.5 cms and the results are excellent for line sowing and broadcasting but very poor in case of dibbling sowing. The highest germination per cent (48.45) is shown by T_7 (T_3S_1– line sowing at 2.5 cm depth) followed by T_1 (46.55), T_8 (46.50), T_3 (46.00), T_2 (45.65) and T_9 (45.50). The poor germination per cent was obtained in T_6 (23.80), T_5 (30.95) and T_4 (31.15). Thus the lowest germination per cent was observed in dibbling method at 4.5 cms depth. This shows that for obtaining maximum number of seedlings from a given quantity of seeds, the correct standardization of depth and method of sowing is most essential factor in the nursery practices.

Plant per cent and number of seedling obtained : If, we examine the table it is revealed that highest value for mean plant per cent and thus total number of seedlings obtained are highest in T_7 (T_3S_1) i.e. 46.55% and 233 seedlings closely followed by T_1 (T_1S_1), 45.50 and 228 seedlings. Treatment T_6 (T_2S_3) produced only 109 seedlings.

The results of this investigation, therefore, consistently exihibit highly significant difference in a similar pattern, for all the characters studied. It is evident that, line sowing and boradcasting, are equally effective whereas, the combinations of line sowing with 2.5 cm and 3.5 cm depth proved equally good, in case of broadcasting better results were shown at 2.5 cm depth. It thus, reveals the suitability at line sowing over broadcasting. The dibbling even at 2.5 cm depth did not give better results which indicate that dibbling of seeds is not at all suitable for this species. The results of this analysis are significant at 0.1% level of probability, which clearly stress the need for finding out suitable indices of sowing, irrigation, depth and other nursery needs for broadcasting more seedlings from a given quantity of seeds, consistent efforts are required in this direction as at present most of the forest tree seeds are sown, depending upon the personnels bias, convenience and experience of supervisions. A lot of seed and money can be saved if scientifically evolved methods are incorporated in the nursery technology.

Requirement of seed under Dehra Dun (North Indian Moist Climatic conditions) : The quantity of seeds required for planting one hectare of land in one year can be calculated by the formula derived by Evans (1982).

Lot of seed needed in kilogram : $\frac{Ha \times N}{S \times PS}$

where,

Ha = Size of annual planting programme.

N = Intended number of seedlings to be planted per hectare.

S = An estimate of survival after planting and the need to fill gap i.e. 90 per cent (in decimal).

PS = Number of plantable plants per kg of seed.

Suppose, the area for annual planting programme of *Azadirachta indica* is one hectare. *Azadirachta indica* generally planted at 3 m × 3 m spacing and therefore, for planting one hectare of area, 1090 plants will be needed. Number of healthy plantable seedlings from one kilogram of seeds are 1554 (observed from this experiment). The survival factor is 90%.

Therefore, the quantity of seeds for afforestation is :

$$\frac{Ha \times N}{S \times PS} = \frac{1 \times 1090}{0.90 \times 1554} = \frac{10900}{13986}$$

$$= 0.780 \text{ kilogram}$$

Conclusion

On the basis of this experiment, it is advisable that neem seed may be sown in the nursery either by line sowing or broadcasting at a depth of 2.5 cm to 3.5 cm. However, line sowing at 2 5 cm depth may be preferred.

SUMMARY

Neem (*Azadirachta indica*) is a very important, multipurpose tree species of drier region of this country. In its growth on poor and hardy soil, it is versatile and hence an excellent species for planting wastelands, and for social forestry. This paper deal with the results of an experiment carried out in the nursery of Silviculture Branch for determining the best combination of method of sowing and optimum depth of sowing and quantity of seeds for afforestation purposes. The results indicated that line sowing and broadcasting are equally effective. The seedling must be protected from frost.

उत्तर भारत की आर्द्र-उष्ण जलवायु दशाओं में एजेडिरेक्टा इण्डिका ए०जुस० की रोपणी विधियों (बोने की रीति तथा बोने का इष्टतम गहराई) का अध्ययन

जी०पी० मैठाणी, बी०के० बहुगुणा व प्यारे लाल

सारांश

नीम (एजेडिक्टा इण्डिका) इस देश के शुष्कतर भागों की बहुत महत्त्वपूर्ण, बहुप्रयोजनी वृक्ष जाति है। घटिया और कड़ी मिट्टियों मे बढ़ने में भी यह सुदक्ष है और इस कारण बंजर भूमियों में वृक्ष लगाने और सामाजिक वानिकी कार्य के लिये यह अत्युत्तम वृक्ष जाति है। प्रस्तुत अभिपत्र मे वन संवर्धन शाखा की पौधशाला मे इस जाति के बीज बोने की रीति और बोने की इष्टतम गहराई तथा वन रोपण के लिये बीजों की मात्रा का सर्वोत्तम सयोग निश्चित करने के लिए किये गये अन्वेषण के परिणाम दिए गए हैं। परिणामों से संकेत मिलता है कि पंक्तियों में बोना और छिटक बुआई दोनों समान रूप से प्रभावकारी हैं। पौधे को पाले से बचाना चाहिये।

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COMPARATIVE STUDIES ON THE HEALING RATE OF BLAZES TAPPED BY 'CUP & LIP' METHOD (CHANNELS) AND 'RILL METHOD' (RILLS) IN *PINUS ROXBURGHII*

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Introduction

Resin tapping was started on experimental scale in U.P. around 1890 which was commercialised in 1896. It was extended to Jammu & Kashmir and H.P. in 1940 and 1945 respectively. (Singh & Asokan, 1984). French Cup & Lip method was employed for resin tapping and it was advocated to tap the trees for five years followed by a rest of 10 years. Later on it was established that continuous tapping could be done wiihout causing harm to the trees. With the increasing demand of resin to meet the requirement of rosin and turpentine industries in the country, resin tapping was intensified and reached a maximum during 1975-76. Thereafter production of resin is continuously falling (Table 1).

Table 1

Resin production in three states of India 1972-73 to 1981-82.

Year	Uttar Pradesh	Himachal Pradesh	Jammu & Kashmir	Total
1972-73	29,852	17,133	4,693	51,678
1973-74	36,493	17,295	8,199	61,987
1974-75	41,793	16,131	13,612	71,536
1975-76	24,813	14,080	33,293	72,186
1976-77	21,016	12,755	32,029	65,800
1977-78	15,577	12,451	37,526	65,554
1978-79	12,961	8,010	40,057	61,028
1979-80	14,209	7,515	28,370	50,094
1980-81	16,801	7,657	30,336	54,794
1981-82	13,950	6,421	25,550	45,921

(Source : Singh & Asokan, 1984).

Past observations on healing rate of blazes made by Cup & Lip method

Studies were initiated in 1919 by Milward in West Almora Forest Division to study the rate of healing of blazes. It has been reported (Champion, 1923) that the average rate of occlusion was about 0.15 cm per annum which may be mainly dependent on the vigour of the trees, supply of water and food material reaching the edges of the wound. Studies were further made by Champion on the rate of healing of resin channels in Chir pine trees in other areas between 1919 and 1922 when the system of continuous tapping, which had replaced the intermittent system, had been in the use for 4 to 6 years. He concluded that the rate of healing of resin channels of dominant trees was about 0.25 cm per year (Joshi, 1975). On the basis of this data, he advocated that resin tapping should be started when the trees reach a girth of 1.7 m at the age of 55 years. He suggested that after completing one round of tapping comprising of 6 complete channels in 30 years, a second round of tapping of 6 complete channels in 30 years over the previous channels could be carried out without difficulty when the trees would attain the age of 115 years (Joshi, 1975).

Further, Joshi (1975, 1984) also made the following observations on the occlusion of resin-channels on a single tree of Pine in West Almora Forest Division tapped for resin under light continuous system for 42 years :

(i) "Under the standard technique of tapping, quinquennial channel is completely filled up by occlusion in about 30 years, under the conditions existing in Kaligarh 16.

(ii) Rate of occlusion is highest at the base of the tree followed by top portion of the channel. The least rate of occlusion is in the middle of the channel.

(iii) The rate of occlusion is adversely affected if the standard width (10 cm) and depth (3.8 cm) of channel is exceeded.

(iv) Interaction of severe fires with wide and deep channels further reduces the rate of occlusion.

(v) Under standard tapping practice, there is no difficulty in carrying out a second round of tapping. There is space left over for further tapping even after the second round".

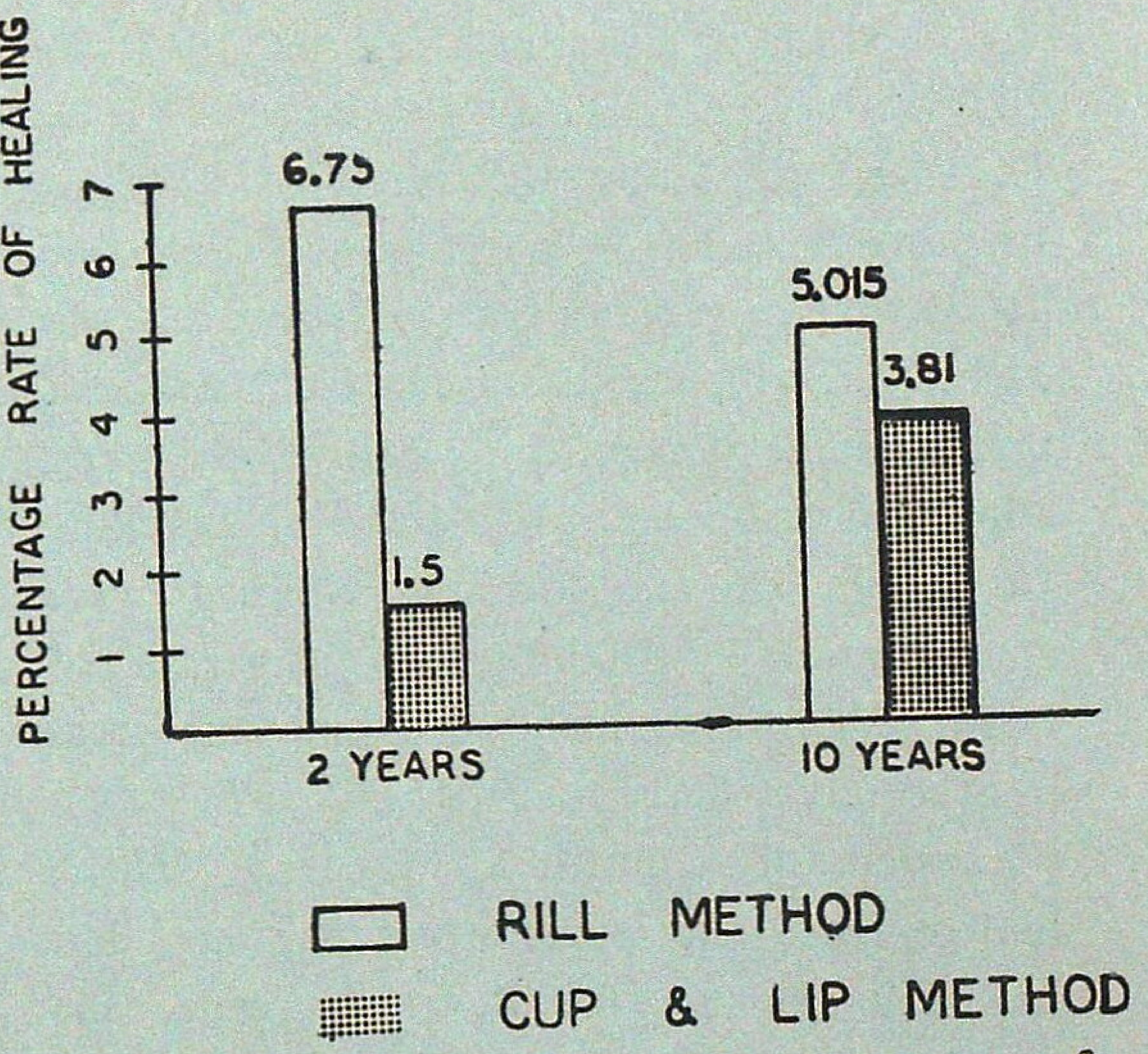
It was observed that considerable damage is caused to Chir pine trees by deep blazes made by Cup & Lip method. Even though the channels were reported to have been completely healed up in about 30 years it has been generally found that the timber obtained from such tapped trees is greatly damaged and is of poor quality. Moreover, trees with such deep channels generally break down during storms. Therefore, Rill metods of resin tapping was evolved by Dr. V.P.S. Verma, ex-Officer-in-Charge, M.F.P. Branch during the last decade to which makes blazes only 2 mm deep in the sapwood (Verma, 1978). The tool used for this purpose is such a fool-proof device that freshening knife can never go deeper than 2 mm and therefore, it was expected that the wood of the trees would not be damaged at all. Studies on healing rate of the blazes made on Chir pine trees by 'Rill' method were conducted to compare with the healing rate of blazes 'Cup & Lip' method.

Methodology

Eighteen trees of *Pinus roxburghii* of

the same diameter class tapped by Rill method and 'Cup & Lip' method each 10 years ago were selected in the demonstration area of New Forest, Dehra Dun. The width of unhealed portion of the blazes tapped by both the methods were measured at three places, i.e. top, middle and bottom and average of these measurements was calculated for each portion separately and then average of width of unhealed portion was calculated. The area of unhealed portion was calculated for each blaze of all the trees. Similarly the trees of same age group tapped five years and two years ago were also recorded. From the data so obtained the total healed areas of the blaze both in the case of Rill and Channel methods was calculated. Then the healing rate was calculated and is recorded in Table 2.

Fig. 1



Bar diagram showing the percentage rate of healing after 2 and 10 years of tapping Chir pine trees of different origin for resin.

Results and Discussions

The data given in Table 2 and the bar diagram (Fig. 1) in respect of percentage of healing after 2 and 10 years of tapping clearly indicate that the percentage rate of healing in the case of blazes made by Rill method is faster than in Cup & Lip method. It can be also seen from Table 2 that rate of healing of blazes made by Rill method ranges from 19.2 to 51.3 cm^2 per year while in the case of blazes made by Cup & Lip method the rate of healing ranges from 4.8 to 12.2 cm^2 which is lower than the Rill method. The trend in the percentage rate of healing shown in the bar diagram does not seem to be commensurate to the period of healing. This may be attributed to the dissimilarity in their rate of growth depending upon the origin or strains of the trees or some unknown Physiological reasons.

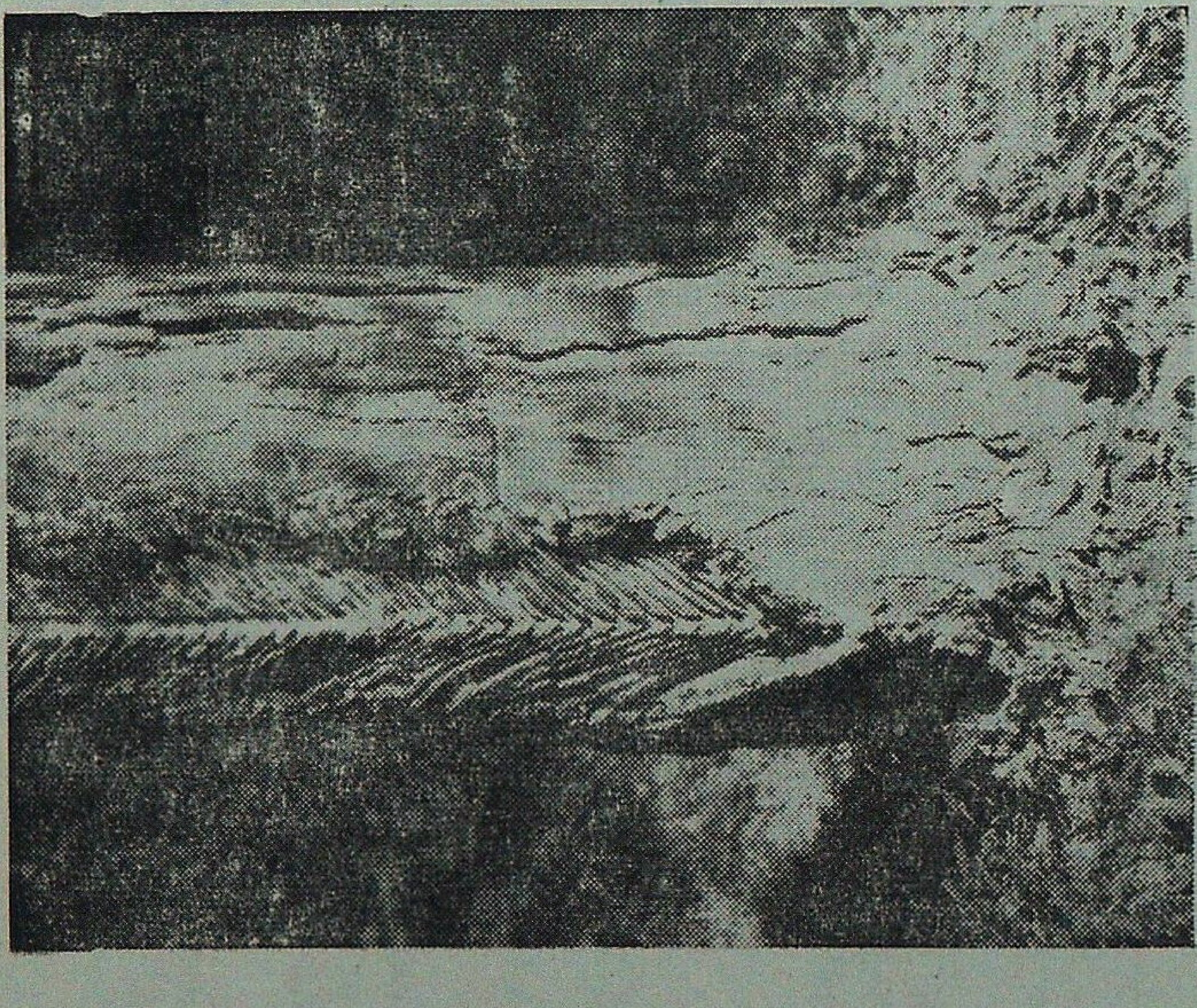
The observations show that the blazes made by Rill method were completely healed up internally as the blazes were only 2 mm deep in the live brak (Fig. 2), whereas in the case of Cup & Lip method the prescribed depth of the blaze is 2.5 cm but invariably the blazes are made much deeper upto 7-10 cm leaving a cavity as the working of the adze has no control on the force applied to make the blaze and control the depth (Fig. 3). This shows that Cup & Lip method causes considerable damage to wood. This is owing to the fact that healing occurs from either side of the blazes and not from top to base of the trees and vice-versa owing to the nature of the cambial activity. In the case of channels made deeper by Cup & Lip method to such an extent, it has been observed that significant amount of wood is lost from the entire circumference of the tree which renders the tree physiologi-

Table 2

Comparative data on the percentage rate of healing of blazes made by Rill and Cup & Lip (channel) method.

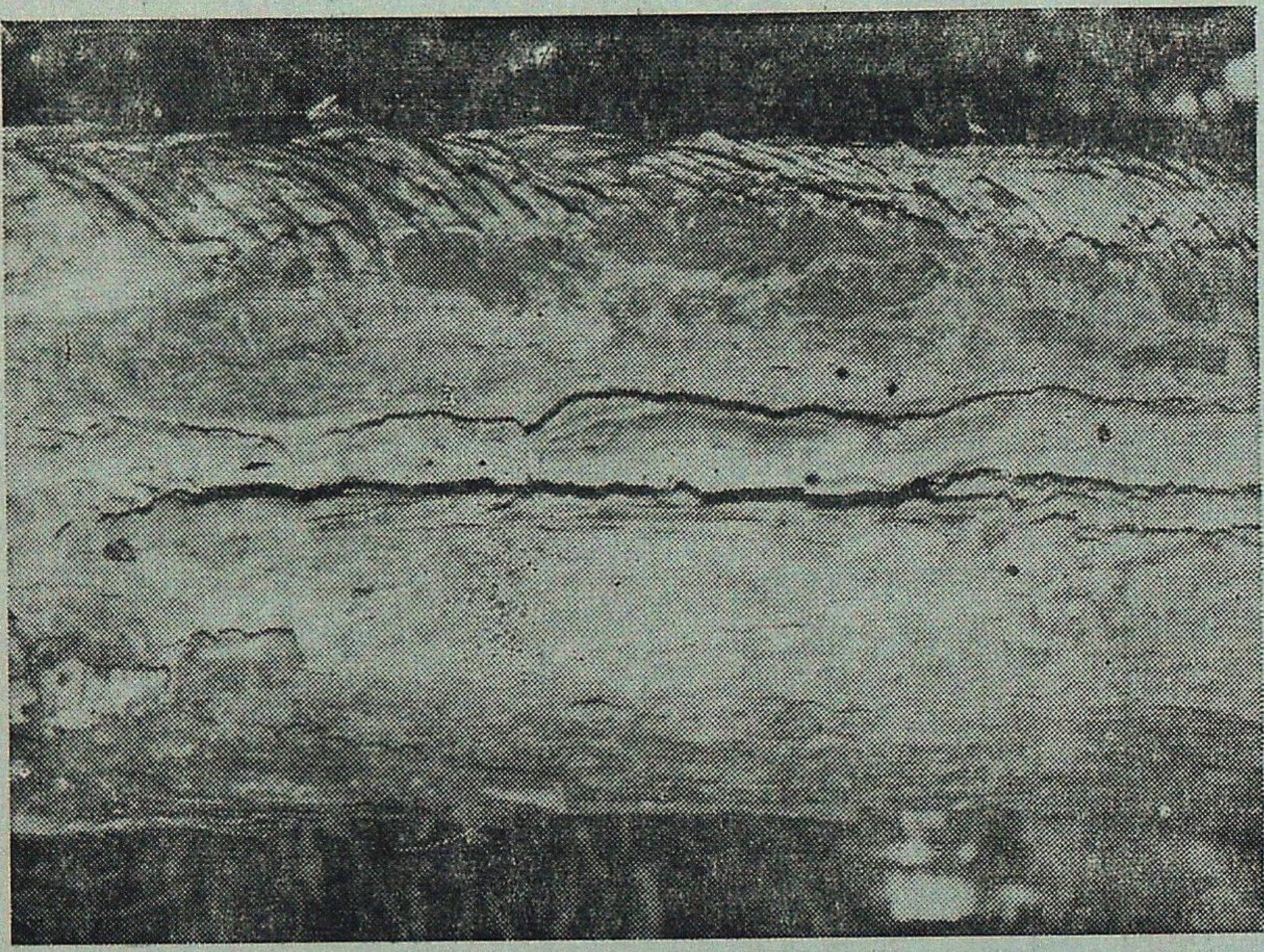
Origin *Pinus roxburghii*	No. of years after tapping	Rill Method					Cup & Lip Method.				
		Total area of blaze (cm^2)	Total area un-healed (cm^2)	Total area healed (cm^2)	Rate of healing/ year (cm^2)	Percent-age rate of healing (%)	Total area of blaze (cm^2)	Total area un-healed (cm^2)	Total area healed (cm^2)	Rate of healing/ year (cm^2)	Percent-age rate of healing (%)
East Almora	10	640	319.3	320.7	32.1	5.015	320	198.1	121.9	12.2	3.81
Rawalpindi and Lansdowne	5	640	380.8	259.2	51.3	8.015	—	—	—	—	—
Rawalpindi and Lansdowne	2	640	553.6	86.4	43.2	6 75	320	310.4	9.6	4.8	1.5
Rawalpindi and Lansdowne.	2	320	281.6	38.4	19.2	6.0	—	—	—	—	—

Fig. 2



Showing blazes made by Rill method were completely healed up internally.

Fig. 3



Showing blazes made by Cup & Lip method are much deeper upto 7-10 cm leaving a cavity.

cally weak from the base and the trees fall victim even to the ordinary storms. Based on these studies it appears appropriate to tap the trees for resin by Rill method which is not detrimental to trees owing to blazes made only 2 mm deep.

SUMMARY

Pines have been commercially tapped for resin by "Cup & Lip method" from the beginning of this century. Recently it has been noticed that considerable damage to the growth and the timber of the pine trees is caused by resin tapping. To solve this problem a new method of tapping called "Rill method" was suggested/evolved by Dr. V.P.S. Verma the then Officer-in-Charge, M.F.P. Branch during the last decade. Studies were undertaken at F.R.I., Dehra Dun to compare the healing rate of blazes tapped by Cup & Lip method and "Rill method" in *Pinus roxburghii*. The studies revealed that while the rate of healing of blazes made by Rill method ranged from 19.2 to 51.3 cm² per year in the case of Cup & Lip method it was from 4.8 to 12.2 cm² per year.

पाइनस राक्सबर्घिआई में प्याला और ओठ, रीति (नालियाँ) और रेला रीति द्वारा टिपान करने पर कटावों के स्वस्थ होने की गति का तुलनात्मक अध्ययन

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सारांश

इस शती के आरम्भ से लीसा निकालने के लिए चीड़ वृक्षों का प्याला और ओठ रीति से व्यापारिक टिपान किया जा रहा है। कुछ समय से इस बात पर ध्यान दिया गया है कि लीसा टिपान करने से चीड़ वृक्षों की बढ़वार और उनके प्रकाष्ठ को काफी हानि पहुंचती है। यह समस्या सुलझाने के लिये टिपान की एक नई रीति "रेला रीति" उपयोग करने का सुझाव पिछले दशक में गौण वनोपज शाखा के तत्कालीन प्रभारी अधिकारी डा॰ वी॰पी॰एस॰ वर्मा ने दिया। वन अनुसन्धान संस्थान, देहरादून में पाइनस राक्सबर्घिआई पर "प्याला और ओठ" तथा "रेला" विधियों से किये गये कटानों के स्वस्थ होने की दर की तुलना करने के लिये अध्ययन शुरू किये गये। इन अध्ययनों से पता चला है कि रेला विधि से किये गये कटावों के पुन: स्वस्थ होने की दर 19.2 से 51.3 वर्ग सेमी॰ प्रतिवर्ष है जब कि प्याला और ओठ रीति में यह दर 4.8 से 12.2 वर्ग सेमी॰ प्रतिवर्ष ही है।

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FOREST FLOOR AND SOIL NUTRIENT INVENTORIES IN AN OLD GROWTH *EUCALYPTUS* PLANTATIONS

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Introduction

With an increasing interest in the plantation forestry for bridging the gap between the demand and supply, more and more land erstwhile not under forests has been brought under plantations. In order to understand the functioning of such eco-systems, detailed studies on nutrient cycling are of paramount importance. These studies can be utilized profitably for a better management of forest plantations and also to predict the effect of such land use systems on soil environment. Numerous studies on nutrient cycling have been carried out in different countries, but adequate inventories of nutrients of the forest floor and the soil are lacking. These inventories are important for predicting the site degradation, as a result of planting and harvesting and provide a sound basis for appraisal of nutrient flow within the ecosystem, although, the vegetation type, and ecoclimatic conditions also play an important role in moderating the nature and magnitude of nutrient cycling.

The purpose of this study was to quantify the nutrients of the forest floor and sub-soil layer in five different species of eucalypts plantations in Nilgiris (Tamil Nadu). These nutrient inventories will help in assessing the long-term impact of eucalypt plantations on the local lateritic soils.

Study site

The study sites were located in North Nilgiris Forest Division, Octacamund, between 10°N to 11°45'N and 76°E to 77°E within the zone of Southern montane wet temperate forest type (Champion and Seth, 1968) having lateritic soils. The average annual temperature is 17°C, average minimum and maximum temperatures are 4°C and 21°C respectively. The annual rainfall ranges from 1500 mm to 2500 mm and is fairly well distributed.

Material and Methods

Studies on forest floor and surface soil layer (0–25 cm) were conducted during February–March, 1986 in five different eucalypt plantations (*Eucalyptus acmenoides*, *E. eugenoides*, *E. paniculata*, *E. pilularis* and *E. propinqua*) which have been now converted into permanent preservation plots (Table 1).

The forest floor in the present study has been considered as described by Pritchett, 1979, L or litter layer consisting of unaltered dead remains of plants and animals, F layer is a zone immediately below the litter consisting of fragmented, partially decomposed organic materials that are sufficiently well preserved to permit identification as to their origin.

Forest floor organic matter was determined by three randomly located 5 m × 5 m

Table 1

Age and growth parameters of the plantations

Stand	Year of planting	Area of the stand (ha)	No. of trees (ha)	Average D.B.H. (cm)	Average height (m)
E. acmenoides	1911	0.2	115	36.5	40.0
E eugenoides	1912	0.12	189	53.6	39.7
E. paniculata	1911	0.2	260	22 8	34.0
E pilularis	1912	0.2	198	52.0	40.0
E propinqua	1911	0.2	225	29.0	27.0

plots in each stand. Litter (L) and partially decomposed layer (F) were separated manually, weighed and sampled for oven dry weight and nutrient analysis Foliage samples were also collected from each stand for nutrient contents. Three samples of humus and surface soil were collected from different randomised blocks of 25×25×25 cm in each plantation for anaysis.

Plant materials were analysed for N, P, K, Ca and Mg and soil samples were analysed for organic carbon, total N, P, K, Ca, Mg and Na and available P, K and Ca, using standard laboratory methods.

Results and Discussions

Nutrient concentration in foliage, litter and decomposing litter : The concentrations of nutrients in foliage, litter and decomposed litter are shown in Table 2. There was a consistent difference in the concentration of nitrogen, phosphorus and magnesium, being maximum in *E. acmenoides* and manimum in *E. eugenoides*, while the concentration of potassium was highest in *E. paniculata* and lowest in *E. pilularis*. Similarly, the concentration of calcium was highest in *E. acmenoides* and lowest in *E. eugenoides*. On an average, the foliage nutrien concentration in all the five species is generally low as compared to be deciduous species which is a general charateristic observed in case of evergreen forest for nutrient conservation mechanism (Jordan, 1985).

The nutrient concentration in the litter was in the decreasing order of calcium followed by nitrogen, potassium, magnesium and phosphorus in respect of all the five species. These results are in general agreement with those reported earlier in case of *Eucalyptus* hybrid (Sharma and Negi, 1985). However, the concentrations of calcium in *E. paniculata*, *E. propinqua* and *E. eugenoides* was more than that of foliage. This is again in confirmity with the earlier observations (Negi, 1984).

With regard to the nutrient concentration in decomposing litter it was in the decreasing order of nitrogen, calcium, potassinm and magnesium. It has also been observed that the nutrient content excepting calcium

Table 2

Nutrient concentration (% on oven dry weight Basis) in Foliage (G) Litter (L) and Decomposed litter (F) of Eucalyptus spp.

Species	Compartment	N	P	K	Ca	Mg
E. acmenoides	G	1.16	0 12	0.41	1 30	0.23
	L	0.41	0.02	0.09	1.00	0.08
	F	0.51	0.04	0.14	0.20	Traces
E. eugenoides	G	0.68	0.06	0.47	0.50	0.07
	I	0.40	0.02	0.08	0.90	0.04
	F	0.60	0.03	0.14	0.20	0.03
E. paniculata	G	0.90	0.10	0.79	1.10	0.12
	L	0.43	0.02	0 17	2.30	0.02
	F	0.65	0.04	0.17	0.70	0.06
E pilularis	G	1.06	0.10	0.42	0.70	0.24
	L	0.32	0.02	0.05	0.60	0.13
	F	0.36	0.03	0.08	0.10	Traces
E. propinqua	G	0.77	0.06	0 46	0.80	0 07
	L	0.54	0.03	0.11	1.30	0.07
	F	0.69	0.05	0.11	0.20	0.02

in decomposing litter was generally higher as compared to the top layer litter. The higher concentration of the these nutrients in the decomposing layer is obviously due to the combined effect of leaching from top layer and microbial activities. On the other hand, the low concentration of calcium in the decomposing layer is presumably due to the fast circulation of this element in case of eucalypts. It is also expected that leachable nutrients (N and K) will further get accumulated in the soil strata (Lambert, 1981 and Negi, 1984).

Nutrient withdrawal from foliage: The differences in the concentration of nutrients between the foliage and litter suggests a probability of nutrient withdrawal from the senescing leaves (Table 3). The withdrawal percentage of different nutrients in different species varies from 30-70 for N, 50-83 for P and 43-83 for Mg. As far as withdrawal of K (76-88%) is concerned, it is likely to be seriously in error since much of the K from senescing leaves might have been leached during the rains rather than withdrawal (Attiwill, 1981). Low and negative withdrawal percentages of Ca can be explained

on the basis of the phenomenon that (i) during abscisson withdrawal of other nutrients reduces the absolute dry weight of the leaf thereby resulting in an over estimate in comparison to the live leaves (Oland, 1963; Hopkinson, 1964; Kozlowski, 1971; Gray, 1983), (ii) litter-fall collection does not necessarily reflect the nutrient status of abscised leaves for the reasons of leaching and contamination of litter (Chapin, 1980), and (iii) the comparison of nutrient concentration in live and abscised leaf at a single time at the year ignores leaching losses and any redistribution that may have occurred earlier (Gray, 1983).

Table 3

Withdrawal percentage of nutrients in different Eucalyptus stands.

Stands	N	P	K	Ca	Mg
E. acmenoides	65	83	78	23	65
E. eugenoides	41	67	83	—80	43
E. paniculata	52	80	78	—109	83
E. pilularis	70	80	88	14	46
E. propinqua	30	50	76	—63	46

Organic matter and nutrient status of forest floor: Organic matter and nutrient status of forest floor is given in Table 4. The organic matter content varies from 1330 to 5020 kg/ha in the litter layer (L), and 2090 to 6824 kg/ha in the decomposing layer (F). The ratio of F/L ranged between 3-4 in *E. pilularis*, *E. eugenoides* and *E. acmenoides* from 1.2 to 1.5 in case of *E. paniculata* and *E. propinqua*. Thus the total organic matter on the floor varies from 3 to 11 t/ha. A careful perusal of Table 4 indicates higher amount of organic matter under *E. paniculata* can be attributed to (i) higher density of trees and (ii) higher Ca and P concentration in the litter as well as in the leaves (Tables 2 and 4, Vitousik, 1984).

The amount of organic matter and nutrient accumulation under eucalypts in the present study was comparatively lower than many other forest stands (Table 5), which could be accounted for the faster rate of decomposition (Pande, 1986; Balagopalan and Jose, 1986) in the prevailing condition.

Organic matter and nutrient status af soil: The content of organic matter, total and available nutrients (kg/ha) is presented in Table 6. The total content of the nutrients in soil under four species is in order of K> N> Ca> Na> P> Mg and in order of N > Ca > K > Na > Mg > P in case of *E. pilularis*. The amount of organic matter ranged from 103 to 144 t/ha, while the C : N ratio ranged from 7 to 9 in all the species excepting *E. propinqua* in which case it was 15. The high amount of organic matter and high C : N ratio under *E. propinqua* is an indication of low rate of organic matter reduction (Swift *et al.*, 1979). It has been observed that available portion of Ca, P and K is 37%, 9% and 3% of the total content, respectively. The available K is only 3% of the total content, which can be accounted for its high leachability. However, high availability of K (25%) is also possible in the drier forests (Lugo and Murphy, 1984 cited by Jordan, 1985).

Table 4

Organic matter in top layer (L) and Decomposing layer (F) and nutrient return (kg/ha) on the forest floor in different stands

Stands	Organic matter			Nutrients				
	L	F	Total	N	P	K	Ca	Mg
E. acmenoides	2068	6808	8876	43	3	12	34	2
E. eugenoides	1692	6160	7852	47	2	10	27	3
E. paniculata	5020	6428	11448	63	4	20	160	5
E. pilularis	1746	6824	8570	30	2	6	18	2
E. propinqua	1330	2090	3420	22	2	4	22	1

Table 5

Storage of organic matter (t/ha) and nutrients (kg/ha) in the different forest floors

Forest floor	Organic matter	N	P	K	Ca	Mg	Source
Eucalyptus stands	3-11	22-63	2-4	4-20	18-160	1-5	Present study
Tropical	27	214	9	22	179	24	Waring and Schlesinger (1985)
Temperate							
Conifer	75	681	60	70	206	53	
Deciduous	22	377	25	53	205	28	
Boreal conifer	114	617	115	109	360	140	
Tulip poplar forests	6	78	5	9	100	—	
Amazon Cattinga forests	22	132	5	10	67	22	Golley (1983)

Table 6

Organic matter (t/ha) and soil nutrient status (0-25 cm) in the different Eucalyptus stand

Stands	C/N Ratio	Organic matter (t/ha)	Nutreints (kg/ha)								
			Total						Available		
			N	P	K	Ca	Mg	Na	P	K	Ca
E. acmenoides	8	127	8767	646	9871	4160	291	1167	40	54	1480
E. eugenoides	7	107	9068	462	11580	4815	420	1136	44	158	1880
E. paniculata	8	133	9564	596	12668	5118	168	1142	40	276	1640
E. pilularis	9	103	6969	407	2822	4719	508	1299	41	139	2574
E. propinqua	15	144	5641	457	15514	5407	168	992	48	69	1240

Soil nutrient reserve in the present study is akin to the temperate forest ecosystems of the world (Table 7). However, it is interesting to note that that the forest floor of these stands is somewhat similar to that of tropical forest as evident from Table 5 and has already been discussed earlier.

Conclusion

It is interesting to note that that the soil nutrient status under these five stands were akin to the temperate forests, while the forest floor behaviour was similar to that of tropical forests. It appears that the maximum amount of nutrient retention in the tropical forest is intrabiotic, while in the temperate forests and in the eucalypts plantations reported here, is extrabiotic as evident from the nutrient content of the foliage. Thus it is clear that the soil nutrient status under these stands is well develoved. In the last, it can be concluded that any forest species has variety of strings to pluck, any combination, of which might result in melody. Thus, growing of forests, on the impoverished substrate might show more adaptive conservational mechanism than those grown on the rich substrates (Jordan and Herrera, 1979 cited by Golley, 1983).

Table 7

Nutrients (kg/ha) in surface Soil in some of the forest stands

Forest Cover	Depths	Soil weight (t/ha)	Carbon (t/ha)	Total nutrients						Source
				N	P	K	Ca	Mg	Na	
Eucalyptus stands	0-25	2479	71	8002	514	10491	4844	311	1147	Present study
Tropical rain forests of Andamans	0-10	1344	24	1344	121	538	—	2419	202	Negi *et al*,, 1987
Amazon Catinga forests	0-21	494	57	1600	47	141	263	31	—	Golley, 1983
Temperate forests	0-10	640	—	3400	430	6000	18000	3580	—	Duvigneaud and De-Smet, 1970

Acknowledgements

The authors are grateful to Thiru S. Sanmughasundaram, I.F.S., Conservator of Forests (Research) for providing the facilities during the course of the study. We are also thankful to S/Shri Frederick Solomans, Research Forester, Tamil Nadu Forest Department and H.D. Thapliyal Research Assistant, Forest Ecology Branch for help rendered in the collection of field data.

SUMMARY

Studies on forest floor and soil nutrient reserve (0-25 cm) under five eucalypts (*E. acmenoides*, *E. eugenoides*, *E. paniculata*, *E. pilularis* and *E. propinqua*) plantations were carried out in the Nilgiris, Tamil Nadu. These studies reveal that the forest floor behaviour was similar to that of tropical forest, while the soil nutrient status was akin to the temperate forest of the world. Thus, the soil nutrient status is well developed under eucalypts plantation.

पुरानी वृद्धि वाले युकेलिप्टस रोपवन का वन तल और उसके मृदा पोष्याहारों की तालिका

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सारांश

पांच युकेलिप्टस जातियों (यु० एक्मेनोआयडिस, यु० युजेनीआर्याडस, यु० पैनिकुलेटा, यु० पिलुलैरिस और यु० प्रोपिनक्वा) के रोपवनों के वन तल और मृदा मे संरक्षित पोष्याहारो (0-25 सेमी०) का अध्ययन नीलगिरी प्रदेश, तमिलनाडु में किया गया। इन अध्ययनों से पता चलता है कि उनमे वन तल का व्यवहार उष्णदेशीय वनों जैसा ही है, किन्तु मृदा पोष्याहारों की स्थिति संसार के समशीतोष्ण वनों के समान हैं। इससे मालूम हुआ कि युकेलिप्टस रोपवनों में मृदा पोष्याहारों की स्थिति सुविकास प्राप्त रहती है।

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PRELIMINARY STUDIES ON METHODOLOGY OF MEASURING THE LIGHT PATTERN BENEATH THE CANOPY OF *PINUS ROXBURGHII* PLANTATION IN WESTERN HIMALAYAS

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Introduction

The influence of the forest in checking the light under the trees is matter of common experience when one eyes are relieved under the woods from the glare of the sun. Light is one of the important climatic factors responsible for the growth and development of plants. The sun is the source of energy for plant processes but not all portions of the solar spectrum are of equal importance for plant growth. The study of light as an ecological factor is complicated by the fact that the sun emits not only the light rays used for photosynthesis, but in addition heat rays and ultra-violet rays; both of which influence many other processes in the plant. Wave lengths between 0.49 and 0.76μ are called light because the eye is sensitive only to these wave lengths and this is also the range of wave lengths primarily involved in photosynthesis. Out of the total radiation reaches the surface of the earth, 35% is reflected and 17.5% is absorbed by the atmosphere and clouds. This leaves only about 47.5% of the solar radiation effective at the level of the biosphere (Linton, 1965). Light measurements have a lot of practical applications in silviculture since it effects the growth and development, productivity, biogeo-chemical cycles and other important processes of the plants. In the present study, a preliminary attempt has been made to quantify the radiation below the canopy of *Pinus roxburghii* plantation.

Description of Study Site

This study was carried out at Kyarighat (31° 0′ N, 77° 5′ E), 23 km from Shimla on Shimla-Kalka road at elevation of 1750 m above mean sea level. These hills are permanent hay lands and *Pinus roxburghii* plantations have been raised in these hay lands to improve the productivity of these lands as well as for increasing the stability of hill slopes and reducing erosion. The soil is clay loam and loamy with 1.5 m depth and slightly acidic in reaction. The region is subjected to high rainfall during monsoon and occasionally covered with snow during winter.

Material and Method

The study was taken up in 30 years old *P. roxburghii* plantation during the year 1983, in the months of June and November respectively. Enumeration of trees in *P. roxburghii* plantation was done for diameter at breast height, total tree height, crown area and crown density by taking the quadrat of 10 m × 10 m area. Twenty quadrats were laid randomly for the purpose. Detail characteristics of *Pinus roxburghii* plantations is given in Table 1.

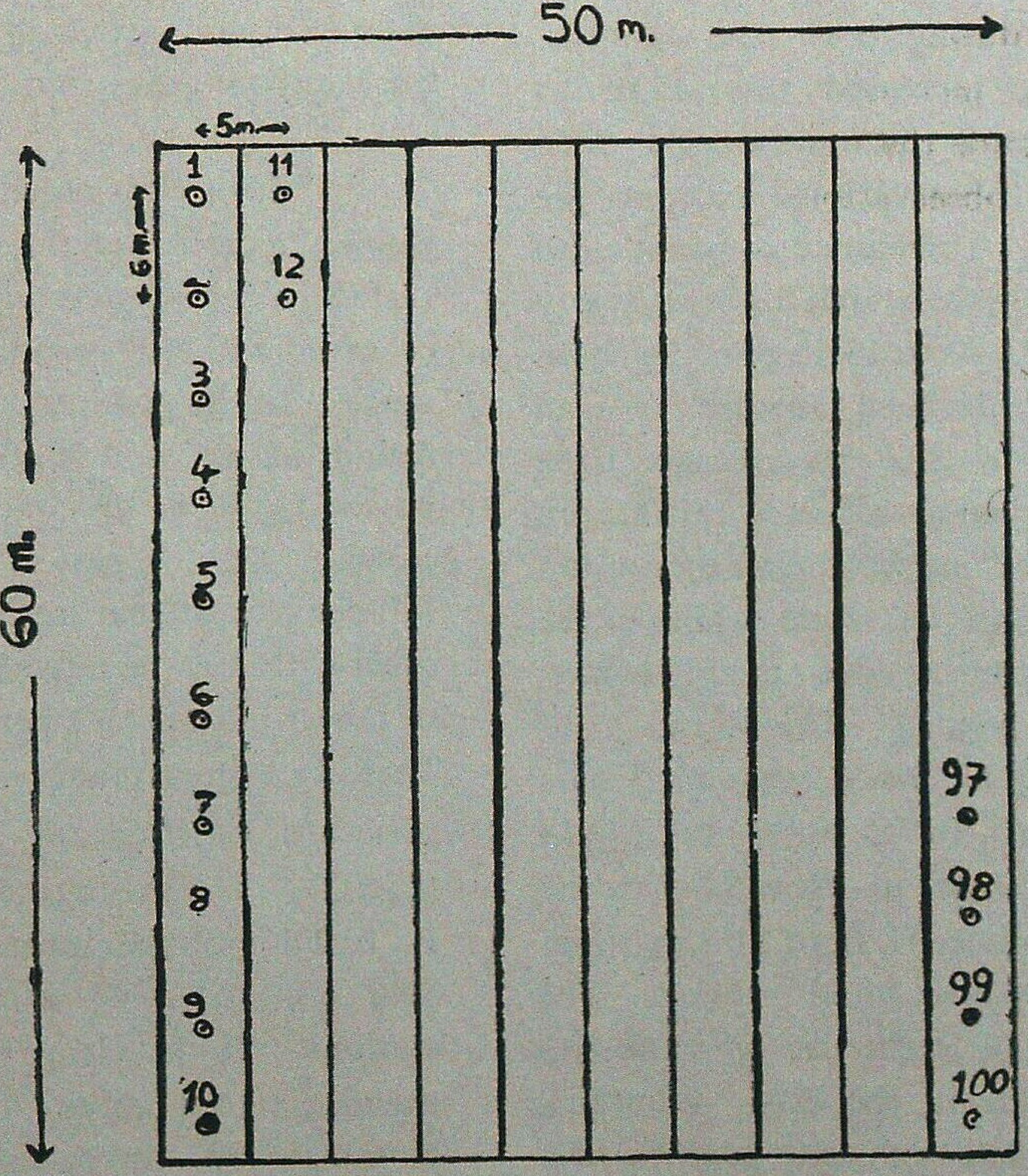
Table 1

Characteristics of Pinus roxburghii plantation

(i)	Age of plantation	—	30 yrs
(ii)	Average D B.H.	—	20.62 cm
(iii)	Average height	—	9.43 m
(iv)	Crown area/tree	—	16.20 m^2
(v)	Crown density	—	85.10%
(vi)	Tree density/ha	—	845
(vii)	Average spacing	—	5 × 5 m

A plot of 60 m × 50 m (0.3 ha) area was selected in *Pinus roxburghii* plantation which was divided into 10 equal parts (Fig. 1). In each part, 10 points were selected in rows at a distance of 6.0 m each. Thus total one hundred points were selected for recording the light intensity. At selected points wooden pegs of one foot height were inserted into the soil for making fixed point for each observation. These pegs were numbered serially from 1 to 100. Recording of observation was started at 8.00 a m. during both the months and continued upto 16.55 p.m. without any break. Fifteen rounds of observation from peg 1 to 100 were completed in each month of the study. A point was selected outside the *P. roxburghii* stand where light intensity observations were recorded after every five

Fig. 1



Design of plot and stations.

minutes for comparison point of view. Observations of light intensity were recorded only in sunny days during both the months of data collection.

Light intensity was measured with the help of "Portable photoelectric photometer" manufactured by Diffusion System Ltd., Hanwell, London; (U.K). Light intensity was measured in lux × 100, both outside and inside the stand.

Results and Discussion

The variation of light intensity with time inside and outside the forest during the months of June and November, 1983 is presented in Table 2. It is clear from the data recorded that the light intensity reached to peak at mid-day in outside and inside the stand during both the months. Light intensity increased upto 12.05 to 12.40 p.m. in outside the stand during both the months of observations but in the month of June, it remained constant upto 13.15 p.m. Inside the stand, light intensity increased upto 12.40 to 13.15 p m. in both the months and declined further. On an average, 78.66 to 88.84% average light intensity is absorbed or reflected of that in the open by the *Pinus roxburghii* plantation during the month of June while in the month of November, this figure comes, 76 52 to 89.71% (Fig. 2). The average light intensity received at forest ground varies between 10.31 to 16.76% of the total light available in the month of November while in the month of June, 11.15 to 21.33% light was available at the stand ground. The mean quantity of light in a stand as a whole varies during the day. Figure 2 shows that outside intensity reached to a peak at mid-day while the time at which peak is reached in a stand will vary with crown characteristics and density. A remarkable part of radiation is reflected from the upper surfaces of a forest which is indicated by the records of albedo : the ratio of reflected to received radiation. *P. roxburghii* plantation shows albedo percentage between 3.25 to 8.71% in the month of November and 3.68 to 7.96% in the month of June respectively. The albedo percentage range from 5 to 20% in forest and vary with the species and with the condition of the foliage (Angstrom, 1925). Angstrom (1925) had observed 18% albedo in young oak, 14% in young pine and 10% in fir. The average value of albedo percentage comes to 5.49% in June and 5.74% in November in *P. roxburghii* plantation and get significant support from the results of Angstrom (1925).

When the radiation is measured below the crowns of the trees at the ground surface, a remarkable range of variation is observed within short intervals of time and space. In the present study it has been found that at one extreme, where sunlight passes through an opening between the crowns, the intensity may be almost 100 per cent of that in the open while at the other extreme, the intensity may be reduced to less than that of 1 per cent in the open. There is a great range of light intensity variation in space in the present study (Fig. 3). The histogram for each month is based on the mean daily light (from 8.00 a.m. to 16.45 p.m.) at each of 100 stations. It is clear from the Fig. 3 that the maximum number of stations in the month of November lies between 50-75 lux × 100 light intensity while in the case of

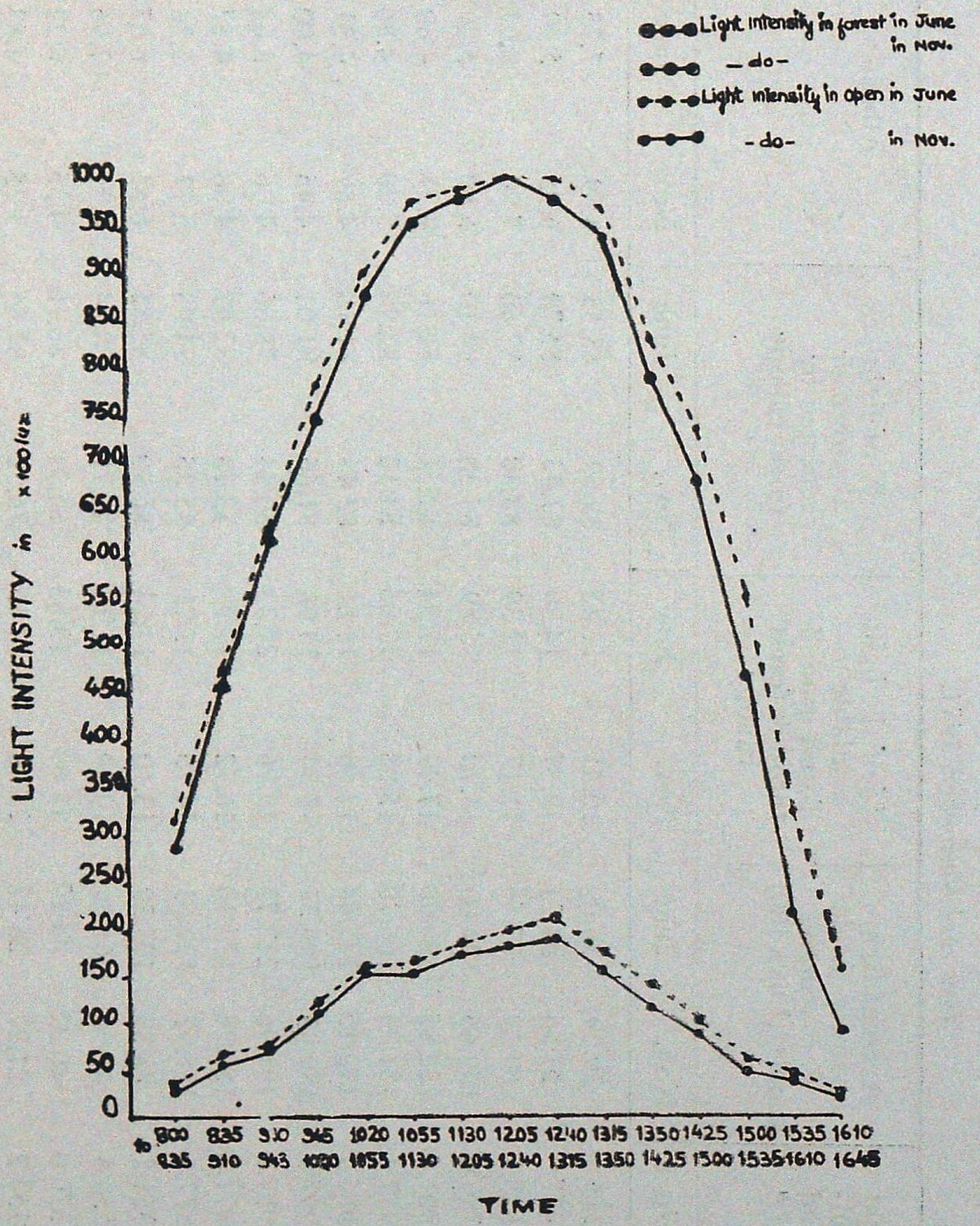
Table 2

Light intensity pattern inside and outside the forest during the day-time in the month of June and November, 1983.

Time (Hrs.)	Average light intensity outside the stand (Lux × 100) *		Average light intensity inside *P. roxburghii* stand**(Lux×100)		% of the light available to forest ground through forest canopy		% of light absorbed or reflected by forest canopy		Albedo	
	Nov.	June	Nov.	June	Nov.	June	Nov.	June	Nov.	June
8.00 to 8.35	285	315	29.39	36.09	10.31	11.45	89.69	88.55	8.69	7.73
8.35 to 9.10	460	477	57.86	68.21	12.57	14.29	87.43	85.70	6.95	5.99
9.10 to 9.45	620	625.7	69.29	77.56	11.17	12.39	88.30	87 60	7.90	7.07
9.45 to 10.20	745.7	780.0	109.65	124.00	14.70	15.89	85.30	84.10	5.80	5.29
10.20 to 10.55	874.2	901.4	152.95	160.90	17.49	17.84	82.51	82.16	4.71	4.60
10 55 to 11.30	955.7	977.1	151.79	166.70	15.88	17.05	84.12	82.94	5.29	4.86
11.30 to 12.05	980.0	985.7	172.15	185.48	17.56	18 81	82.44	81.18	4.69	4.31
12.05 to 12.40	997.1	997.1	182.93	199.32	18 34	19 98	81.66	81.01	4.45	4.00
12.40 to 13.15	971.4	997.1	191.96	212.73	19.76	21.33	80.24	78.66	4 06	3.68
13.15 to 13.50	934.2	971.4	156.28	174.10	16.72	17.92	83.28	82.07	4.98	4.57
13.50 to 14.25	785.7	877.1	115.97	139.63	14.75	15.71	85.25	84.08	5.77	5.28
14.25 to 15.00	674.4	731.1	88.39	103.39	13.10	14.14	86.90	85.85	6.63	6 07
15.00 to 15.35	465.7	550.4	47.96	61.39	10.29	11.15	89.71	88.84	8.71	7.96
15.35 to 16.10	215.7	320.0	40.32	44.27	18.69	13.83	81.31	86.16	4.35	6.22
16.10 to 16.45	90.57	154.2	21.27	26.47	23.48	17.15	76.52	82.85	3.25	4.83

* Average of five minutes interval.
** Average of 100 points.

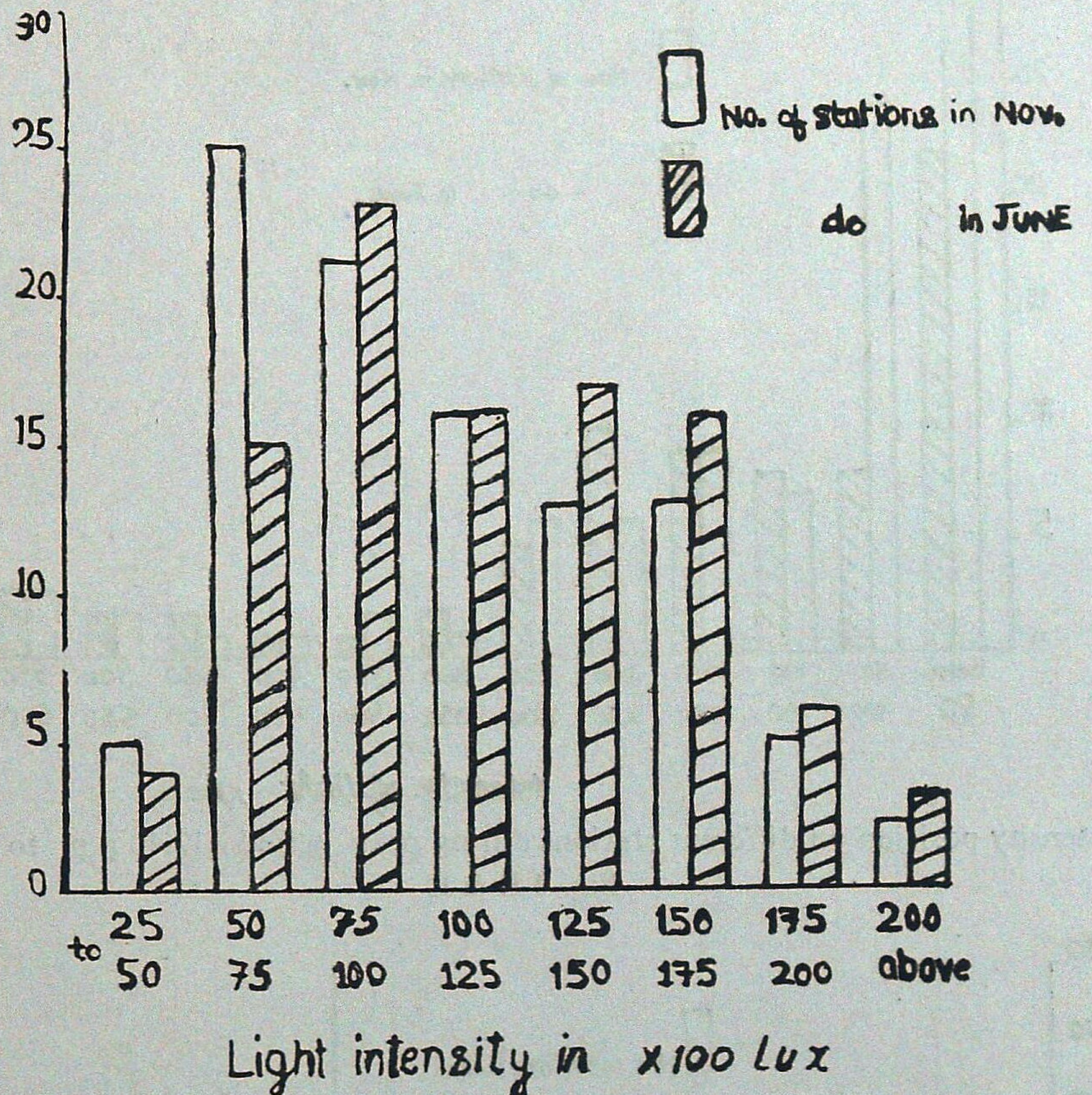
Fig. 2



Light intensity pattern inside and outside the stand at different time.

June, maximum number lies between 75-100 lux × 100 light intensity. Maximum light intensity reached to the forest surface during 12.40 p.m. to 13.15 p.m. and distribution of light intensity on different station between 12.40 p.m. to 13.15 p.m. has been presented in Fig. 4 A. Distribution of light intensity during 8.00 a.m. to 8.35 a.m. and 16.10 p.m. to 16.45 p.m. and the position of light intensity on different station is depicted in Fig. 4B and C. The position of light intensity fallen on different stations during time hours of the present study differs with time and space. Logan and Peterson (1964) concluded the same pattern of light intensity in the 80-years old red and white pine stands. Ovington and Madgwick (1955) had studied the light

Fig. 3

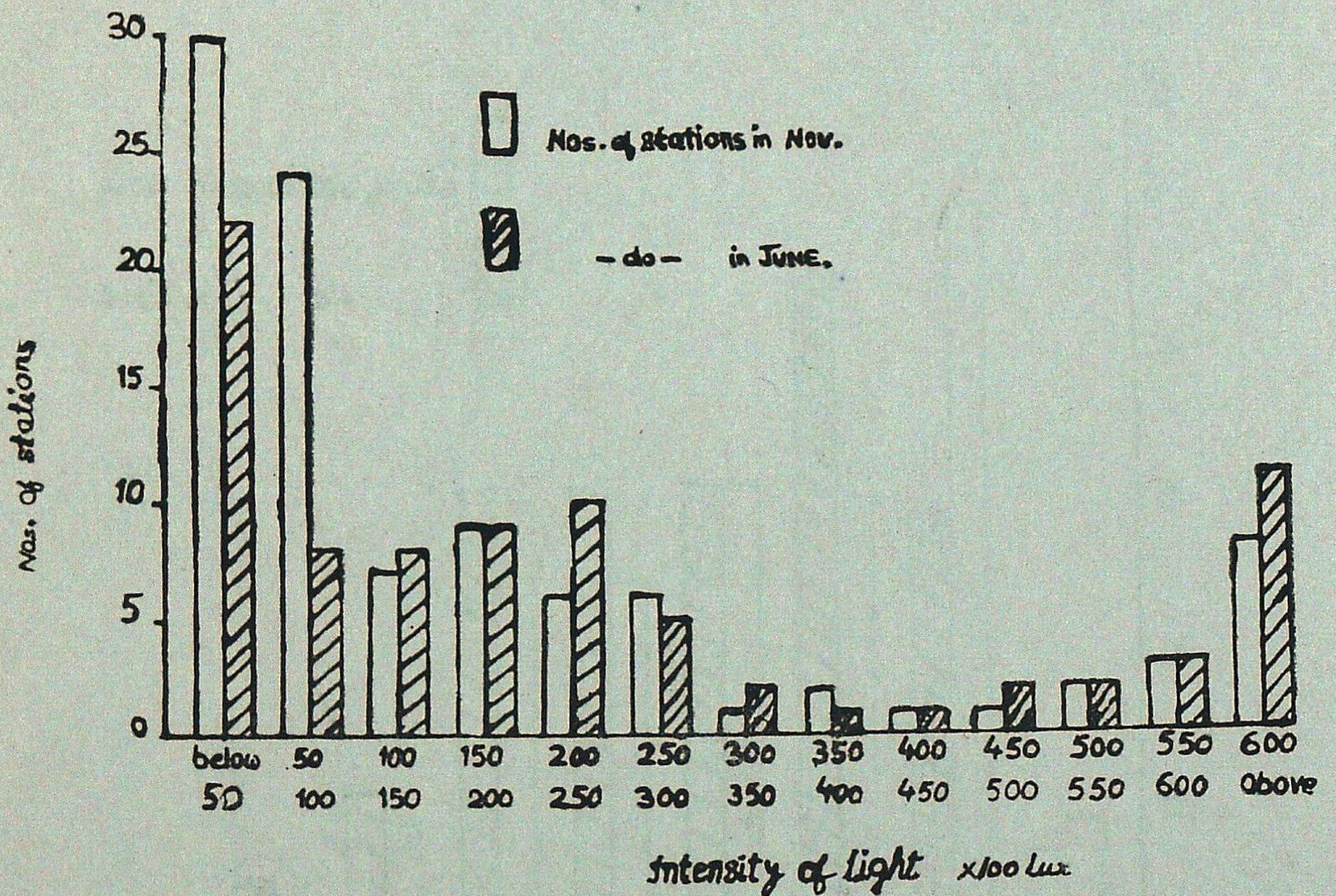


Spatial distribution of light on different stations.

intensity pattern beneath different forest plantations in England in the months of April and August and concluded that conifers allow the least light to penetrate than the deciduous species. The percentage of penetrating light in the forest tends to decrease as the light in the open increases.

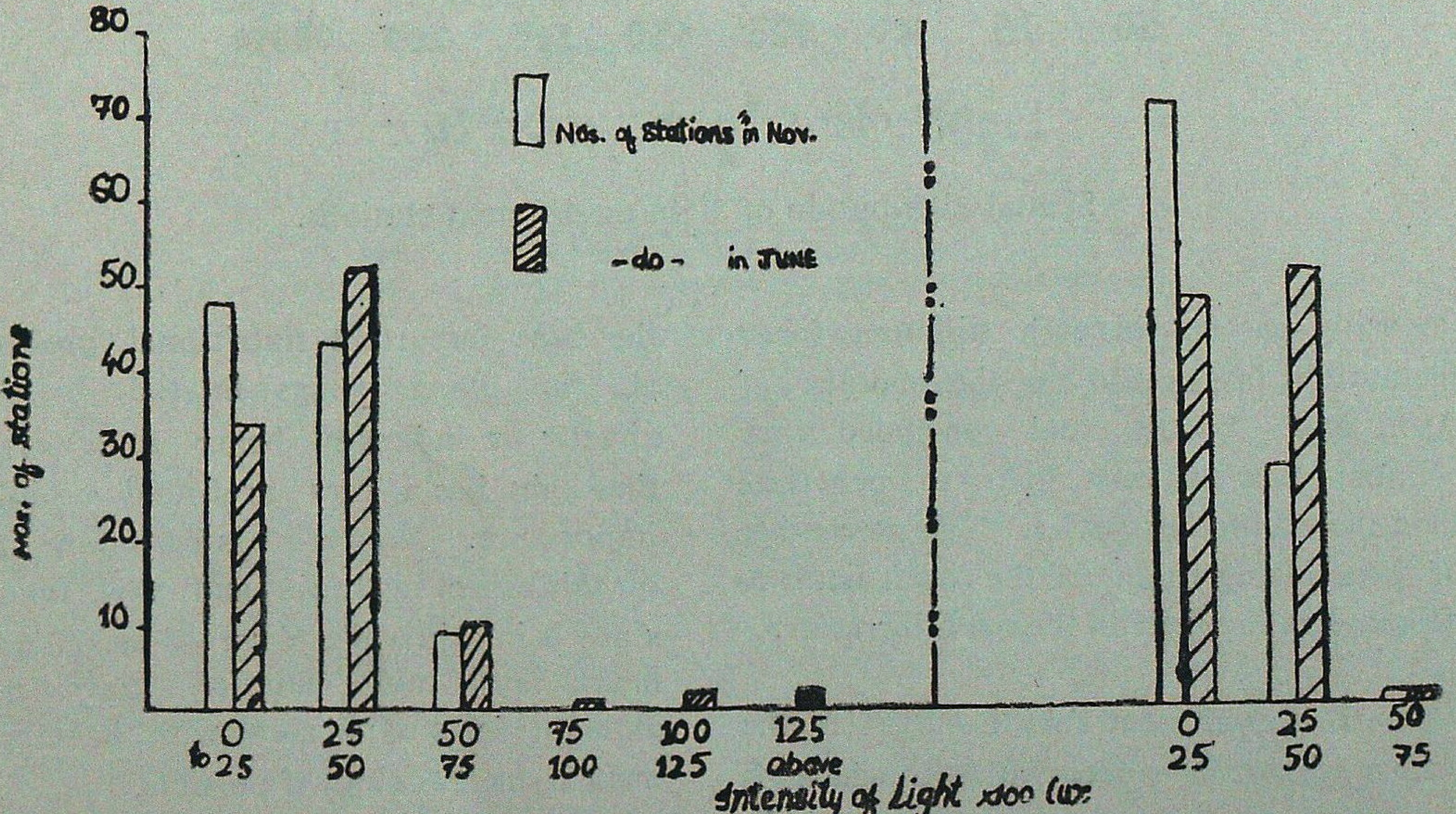
It is established fact that light is the primary factor in photosynthesis which is the base important nutritional process of all the living beings in the biosphere directly or indirectly hence it is evident that light has a very profound ecological importance. No work has been done so far on this aspect in India and this type of study is in a juvenile phase of development hence need more detailed study under different forest types along with the improvement in methodology if possible.

Fig. 4 A



A light intensity position on different stations during peak period (12.40 p.m. to 13.15 p.m.)

Fig. 4 B & C



Light intensity position on different stations during :

Morning period (8.00 a.m. to 8.35 a.m.) Evening period (4.10 p.m. to 4.45 p.m.)

SUMMARY

The present investigation deals with the preliminary studies on methodology of measuring and quantification of light beneath the canopy of *P. roxburghii* plantation in Western Himalayas.

पश्चिमी हिमालय प्रदेश में पाइनस रौक्सबर्घिआई रोपवनों में वितान के नीचे प्रकाश सज्जा नापने की रीतियों के बारे में प्रारम्भिक अध्ययन

आर० पी० सिंह व एम० के० गुप्त

सारांश

प्रस्तुत अन्वेषण में पश्चिमी हिमालय प्रदेश के पा० रौक्सबर्घिआई रोपवनों के वितान के नीचे प्रकाश को नापने और उसकी मात्राएं बताने की रीति सम्बन्धी किए गए प्रारम्भिक अध्ययनों को बताया गया है।

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EFFECT OF SEEDLING SIZE ON THE GROWTH OF TRANSPLANTED SPRUCE SEEDLINGS IN THE NURSERY

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Introduction

The spruce (*Picea smithiana* Wall. ex Boiss.) seedlings raised in germination beds are transplanted at the age of about sixteen months from the time of sowing and are grown in transplant beds for another two years before their planting out (Singh *et al.*, 1984). The object of transplanting or lining out is to provide greater space for the development of the seedlings in the transplant beds and to encourage the formation of fibrous and compact root system in them, and also to achieve high root : shoot ratio of the seedling stock This would not happen if the seedlings are allowed to grow undisturbed in the germination beds (Aldhous, 1975). Khanna (1977) also indicated that transplanting inhibits tap root formation and the seedlings develop small compact fibrous root system, making their planting out easier and safer with reduced mortality.

Seedlings are usually lifted from the germination beds and transplanted either at the end of first or second growing season. Seedlings less than 1½ inches or 4 cm tall are too small to be handled easily and quickly and are usually discarded (Aldhous, 1975). No information was, however, available on the effect of seedling size on the growth of transplanted spruce seedlings in the nursery, hence the present study was accordingly undertaken.

Materials and Methods

About sixteen months old spruce seedlings raised in Shillaru Nursery (2400 m elevation) were used in this experiment. The seedlings were grouped in five classes based on their heights, viz., less than 7.5 cm (T_1); 7.5 cm to $<$12.5 cm (T_2); 12.5 cm to $<$ 17.5 cm (T_3); 17.5 cm to $<$22.5 cm (T_4) and more than 22.5 cm (T_5). These were transplanted in the same nursery on 7th August, 1982 as transplanting done during first fortnight of August results in higher survival and better growth of seedlings (Singh *et al.*, 1986). Each treatment was replicated-six times in a randomized block design. Ninety-six seedlings were pricked out in each treatment at a spacing of 15 $\times$8 cm. Before transplanting, roots of all seedlings were clipped leaving 10 cm root intact so as to ensure higher survival and better growth of seedlings (Singh *et al.*, 1984). The roots of all the seedlings were protected from drying up by placing them in a moist gunny cloth. All the seedlings were transplanted manually in 15 cm deep furrows in such a manner that the seedlings stood firm enough in the transplant beds as to preclude their uprooting by a gentle, steady pull.

The seedlings were grown in the transplant beds for two years. The transplant beds were weeded and irrigated as and when required. During first year, the transplant beds were provided with the partial shade with the help of the screens of wooden battens of 125 × 2.0 × 0.03 cm dimensions. The survival count of the seedling was done every month and height of seedlings was recorded in June and November each year.

On uprooting the seedlings in July, 1984 these were transported to the laboratory in a moist gunny cloth. The studies made in laboratory included (i) seedling height, (ii) tap root length, (iii) dry weight of stem and (iv) dry weight of root. Dry weight determination was done after drying the samples in an oven at 80°C to a constant weight.

Results and Discussion

The survival percentage increased with an increase in the height of the seedlings. Statistical analysis of the survival percentage recorded in July, 1984 after arc sine transformation (Snedecor and Cochran, 1967) showed that the survival percentage was significantly (at 1% level) lower in case of seedlings below 7.5 cm in height than those of the remaining classes which, however, did not differ significantly from each other except T_2 which differed significantly (at 1% level) from the treatments T_3, T_4 and T_5. Root : shoot dry weights also increased with an increase in the seedling height, however, the same did not differ significantly (at 1% level) from each other.

The trend of height growth under different treatments was broadly the same as for survival percentage and the seedlings below 7.5 cm in height lagged behind all the other seedling size classes which, however, did not differ much from each other.

Table 1

Survival percentage and growth under different treatments.

Parameters	T_1	T_2	T_3	T_4	T_5	C.D. at 0.01
Survival %, July, 1984	5.83	73.64	87.08	91.64	91.38	6.18
Plant height (cm) July, 1984	17.06	28.15	33.57	38.57	43.79	17.01
Root length (cm) July, 1984	20.82	26.99	29.08	30.55	33.28	1.80
Shoot dry weight (gm) plant, July, 1984	13.16	25.78	27.99	30.21	31.82	1.86
Root dry weight (gm)/plant, July, 1984	4.69	5.55	5.99	6.19	6.57	0.33

Statistical analysis of the seedling heights recorded in July, 1984 showed that the seedling below 7.5 cm in height were significantly (at 1% level) shorter than those of the remaining classes except T_2 and T_3. All other height classes, however, did not differ significantly from each other.

Table 2

Height growth under different treatments.

Treatments	Initial height (cm) August, 1982	Final height (cm) July, 1984	Height growth (cm)
T_1	6.25	17.06	10.18
T_2	10.28	28 15	5.87
T_3	15.07	33 57	18.50
T_4	18 33	38.57	20.24
T_5	23.50	43.79	20 29

Table 3

Root growth under different treatments

Treatments	Initial root length (cm) Aug, 1982	Final root length (cm) July, 1984	Root growth (cm)
T_1	10.0	20.82	10.82
T_2	10.0	26.99	16.99
T_3	10.0	29.08	19.08
T_4	10 0	30.55	20.55
T_5	10.0	33.28	23.28

The root length also increased with an increase in the height of the seedlings. The seedlings less than 7.5 cm in height had comparatively shorter root length than those of the remaining seedling size classes

The results of this study indicated that the performance of seedlings below 7.5 cm in height in terms of both survival and growth was the poorest as compared to other seedling sizes. The seedlings in height classes of 7.5 cm—< 12.5 cm also had comparatively lower survival and lesser growth rates than those of the remaining classes. Nursery grown spruce seedlings of 30 cm and above in height, which generally perform well in the field, are considered to be the optimum plantable size for planting out in the field (Conifers Research Centre, unpublished data). Considering this on the basis of the above studies, it could therefore, be stated that in order to ensure higher survival and better growth of transplanted spruce seedlings in the nursery as well as to maximise the production of optimum plantable stock, spruce seedlings below 12.5 cm in height should be culled at the time of transplanting.

SUMMARY

An experiment was undertaken to study the effect of seedlings size on the growth of transplanted spruce seedlings in the nursery Studies made include observations on survival and growth of seedlings under five different classes based on their hieghts viz. less than 7.5 cm; 7.5 cm to < 12.5 cm; 12.5 cm to < 17.5 cm; 17.5 cm to 22.5 cm and more than 22.5 cm. The performance of the seedlings below 7.5 cm in height in terms of both survival and growth was the poorest as compared to all other classes followed by the seedlings of 7.5 cm—<12.5 cm height classes which also resulted in lower survival and poorer growth rate than those of the remaining three classes. Seedlings below 12.5 cm in height should, therefore, be culled at the time of transplanting.

रोपणी में प्रतिरोपित प्रसरल पौधों की बढ़वार पर पौधों के आकार का प्रभाव

ओमबीर सिंह, एस० भगत व एस०पी० चौकियाल

सारांश

रोपणी में प्रसरल के पौधे प्रतिरोपित करने पर उनकी बढ़वार पर रोपे गए पौधों के आकार के प्रभाव का अध्ययन करने के लिए एक सपरीक्षण आरम्भ किया गया। इन अध्ययनों में पौधों की अतिजीविता और बढ़वार के पर्यवेक्षण उनकी ऊंचाई के अनुसार पांच श्रेणियों में बांटकर किये गये अर्थात् 7.5 सेमी० से कम, 7.5 से 12.5 सेमी० 12.5 से 17.5 सेमी०, 17.5 से 22.5 सेमी० और 22.5 सेमी० से अधिक। 7.5 सेमी० से कम ऊंचाई वाले पौधों की सक्रियता अतिजीविता और वृद्धि दर दोनो के विचार से अन्य सभी श्रेणियों के पौधों की तुलना में सबसे घटिया रही, जिससे ऊपर 7.5 सेमी० से 12.5 सेमी० ऊंचाई की श्रेणी वाले पौधे आए हैं जिनकी अतिजीविता और बढ़ने की दर अन्य तीनों श्रेणियों के पौधों की तुलना में घटकर रहे। इसलिए 12.5 सेमी० से कम ऊंचाई वाले पौधे प्रतिरोपण करते समय चुनकर अलग फेंक देने चाहिएं।

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SWARMING, SEX-RATIO, SEXUAL DIMORPHISM, WEIGHT AND MOISTURE CONTENT IN *MICROTERMES UNICOLOR* SNYDER (ISOPTERA : TERMITIDAE)

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Introduction

Termites are well known for their social habits. A termite colony comprises mainly of three castes viz., soldiers, workers and reproductives each of which are allocated different specialised functions. All the castes are equally important in proper functioning of a termite colony. The reproductive caste only is responsible for propagation and dispersal. Number of new pairs invariably depend on the numbers of both the sexes (sex-ratio).

M. unicolor is widely distributed in India and Pakistan. An account of its biology has been given by Mathur and Sen-Sarma (1960) and Roonwal (1970a). This paper gives an account of sex-ratio, sexual dimorphism, weight and moisture content in *M. unicolor.*

Materials and Methods

Alates were collected by nets in flash light. Sexes were separated by examining the 7th sternum of the female.

For sexual dimorphism, biometric studies were made for 22 males and 24 females, body parts were measured as recommended by Roonwal (1970b) including the length of antennae and metatibia. Freshly emerged alates were brought into the laboratory in a sealed polythene bag. Body weights were taken individually for males and females (32 males and 39 females) in a chemical balance. They were dried in an air oven at 105°C for loss of moisture and percentage of moisture cantent.

A chi-square (χ^2) test using the Yates' correction for continuity (Jones *et al.*, 1981) with one degree of freedom was used to test for significent deviation from a 50 : 50 sex ratio for individual swarms, individual colonies and all colonies put together. For biometric studies student 't' test was applied,

Results and Discussion

Swarming and sex ratio : Swarming was observed in the month of June during 1984 and 1985. In both the years, it had rained during the day time. After first heavy shower swarming had occurred in clear nights. On all occasions, swarming occurred in between 7.30 to 9.00 p.m., exodus being, maximum at 8.00 p.m. Many tiny "exit holes" were made by workers on ground at the swarming sites through which imagos emerged out one by one or in a

* Disease Insect Survey.

continuous stream. Soldiers and workers (major and minor) were seen guarding the exit holes. It was observed that when swarming stopped, all the workers and soldiers gradually, retreated into nest. Thereafter, the workers plugged the exit holes from inner side. From a colony, swarming may occur two to three times within one or two weekes.

Table 1 shows the places and time of swarming, number and percentage of males and females in *M. unicolor*. During of swarming episodes from four different colonies, a total of 5,855 alates were captured. Collection from same nest on different dates denotes of different swarm episodes of the same nest. No significant deviation from 50 : 50 sex ratio was observed in four of the seven swarms, however in swarms from different colonies, only one out of 4 colonies conformed to the 50 : 50 ratio. In colony no. 2 deviation was significant at 1% level while in 3 and 4 colony deviation was significant at 0.1% level. Sex ratio for all colonies statistically deviated from 50 : 50 ratio at 0.1% level (χ^2-test).

Sexual dimorphism : The biometric data of

Table 1

Number and percentage of swarming alates by colony and capture date

Colony	Date and time of swarming	Place of Swarming	Total	Male		Female		χ^2
				N	%	N	%	
1.	10.6.84 7.45 pm	Jabalpur	272	124	45.59	148	54.41	0.97 N.S.
1.	11.6.84 8.00 pm	-do-	84	39	46.43	45	53.57	0.30 N.S.
1.	13.6.84 8.15 pm	-do-	374	178	47.50	196	52.41	0.77 N.S.
2.	9.6.85 8.30 pm	-do-	3865	1966	50.87	1899	49.13	1.13 N.S.
2.	10.6.85 8.30 pm	-do-	635	375	59.06	260	40.94	20.47 xxx
3.	10.6.85 8.00 pm	-do-	259	170	65.64	89	34.36	24.71 xxx
4.	26.6.85 8.00 pm	Khamtara Sehora range, Jabalpur Division	366	216	59.02	150	40.98	11.54 xxx
		Grand Total.	5855	3068	52.40	2787	47.60	13.39 xxx

N.S. = Not significant. xxx = Significant at 0.1% level of probability.

different body parts of alates are given in Table 2. The analysis of the data revealed that the body length and abdominal width were higher in females ($P<0.001$, 't' test). However, maximum width of head with eyes in males was somewhat significantly higher than in females at 5% level of probability.

Body weight and moisture content : Table 3 gives range, mean values of body weight and moisture content in freshly swarmed alates between males and females. Females were distinctlly heavier than males at 0.1% level of probability in wet weight, dry weight as well as in the absolute water loss. The moisture content and the percentage of water losses in terms of wet weight was somewhat higher (at 5% level) in females.

Discussion

In *M. unicolor*, swarming has been recorded in early summer in North India and July to August in Pakistan (Mathur and Sen-Sarma, 1960: Ahmad, 1955). At Jabalpur, swarmings were observed in the month of June. The sex ratio varies from equal to unequal between males and females (Roonwal, 1975). Roonwal and Ra hore (1972) reported that male dominates over female in *Anacanthotermes macrocephalus* (Degn.) and *Microtermes mycophagus* (Disneus.). Roonwal and Verma (1973) observed dominance of the female in *Microcerotermes raja* Roonwal & Bose. Jones *et al.* (1981) in *Pterotermes occidentatus* (Walker) found that sex ratio between males and females was 50 : 50. In case of *Nasuti termes dunensis* Chatterjee and Thakur McMahan, *et al* (1983) have reported approximately 50 : 50 sex ratio but in one colony they found all the males (283). In *unicolor* males predominated females and

Table 2

Measurements (in mm) of alate of M. unicolor

Particulars	Male n = 22		Female n = 24		Significance
	X̄	±S.D.	X̄	±S.D.	
Total length of head and body with wings.	16.28	0.44	16.87	0.55	xxx
Total length of head and body without wings.	9.47	0.61	10.44	0.69	xxx
Maximum width of abdomen.	2.40	0 09	2.66	0.14	xxx
Maximum width of head with eyes.	1.50	0.03	1.48	0.03	x
Length of antennae.	2.13	0.04	2.14	0.05	NS
Length of metatibia.	1.51	0.05	1.50	0.04	NS

N.S. = Not significant. x = at 5% level of probability. xxx = at 0.1% level of probability.

Table 3

Range and mean values of body weight (mg) and moisture content of freshly swarmed alates of M. unicolor.

Particulars	Male n = 32		Female n = 39		Significance
	$\bar{X}$	±S.D.	$\bar{X}$	±S.D.	
Wet weight	15.27	0.84	18.09	0.67	xxx
Dry weight	8.98	1.05	10.08	0.76	xxx
Moisture content by weight (loss of water by drying).	6.28	1.12	9.01	0.76	xxx
% of moisture content (in terms of wet weight)	41.09	6.64	44.28	3.81	x

x = Significant at 5% level of probability.
xxx = Significant at 0.1% level of probability.

skewed in one direction. Lacy (1980) have also suggested that fitness of termite species would be increased by having one sex predominance.

Sexual dimorphism by and large weakly marked in the order Isoptera (Roonwal, 1975; Noirot, 1955). Roonwal and Rathor (1972) did not find any difference between the male and the female in *A. macrocephalus*. Roonwlal and Verma (1973) observed weakly marked sexual dimorphism in *M. raja* but in *M. obesi*, they found strongly marked dimorphism.

In *M. unicolor* sexual dimorphism is strongly marked in the total body length.

With regards to body weight, Roonwal and Verma (1973) reported that in *M. obesi* females were found heavier than males both in wet and dry weight but the sexes as such did not differ in the percentage of moisture content of the body. In *M. unicolor* females are found distinctly heavier than males in wet and dry weigth, Sexes were also differ in the percentage of moisture content in body.

Aknowledgement

Authors are thankful to Dr. M.L. Thakur for identification of termite species.

SUMMARY

Swarming, Sex ratio, sexual dimorphism, weight and moisture content in *M. unicolor* have been discussed. Swarming was recorded in between 7.30 p.m. to 9.00 p.m. in the month of June. Sex ratio for all colonies statistically deviated from 50 : 50 ratio at 0.1% level of probability. Sexual dimorphism was found significantly differ in regards of total body length and maximum width of abdomen. Females were distinctly heavier than males in wet and dry weight and loss of moisture. In percentage of moisture content in body, females are somewhat heavier than males.

माइक्रोटर्मिस युनिकलर स्नायडर (वल्मगण : वल्मवश) दीमकों का झुण्ड बनकर उड़ना, यौन अनुपात, यौन द्विरूपिता तथा भार और नमी मात्रा

सुशील कुमार, एच०आर० खान व लालजी प्रसाद

सारांश

प्रस्तुत अभिपत्र में मा० युनिकलर के झुण्ड बनाने, यौन अनुपात, यौन द्विरूपिता, भार और नमी मात्रा का विवेचन किया गया है । झुण्ड बनाकर इसका उड़ना जून मास में 7.30 मध्याह्न पश्चात से 9.30 मध्याह्न पश्चात के बीच होता देखा गया। यौन अनुपात सम्भाविता के 0.1% स्तर पर सभी उपनिवेशों में 50 : 50 अनुपात से सांख्यिकीत: विचलित होता पाया गया । यौन द्विरूपिता शरीर की कुल लम्बाई और उदर की अधिकतम चौड़ाई के विषय में सार्थकत: भिन्न पाई गई आर्द्र और शुष्क भार की तथा नमी हानि नरों की तुलना में मादा में अधिक भारी पाई गई । शरीर के नमी मात्रा-प्रतिशत में मादा नरों की अपेक्षा कुछ अधिक भारी होती है ।

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RESEARCH NOTES

(I)

A NEW RECORD OF THE INSECT PESTS OF KHUKAN, *DUABANGA GRANDIFLORA* (ROXB. EX DE) WALP.

Khukan, *Duabanga grandiflora* is a large, deciduous fast growing indigenous tree species of tremendous economic value in Assam and Arunachal Pradesh and Meghalaya (Sastri, 1952). Its wood is straight, moderately strong, light in weight and browning in colour. It is used in making furniture, wall boardings etc. Being its fast growing and economic value, a large scale afforestation is being done by State Forest Departments of above States. Beeson (1941) descirbed a few borers and defoliators of this species. Later, Mathur and Singh (1959) reviewed nealy 23 insects namely *Aeolesthes holosericea* Fab., *Aetholix flavibasalis* Guenee, *Artimpaza obscura* Gardner, *Crossotarsus saundersi* Chapuis, *Dihammus cervinus* Hope, *D. elongatus* Breuning, *D. punctifrons* Gahan, *Gerontha captiosella* Walk., *Hoplocerambyx spinicornis* Newman, *Margaronia hilaralis* Walk., *Odontotermes parvidens* Holmgren, *Opogona xanthocrita* Meyrick, *Platypus solidus* Wlk., *podontia quatuordecimpunctata* Linn., *Selepa celtis* Moore, *Xyleborus bicolor* Blaudford, *X. semigranosus* Blaudford, *Xyleutes ceramica* Wlk., *Xylocopa aestuans* Linn., *X. verticalis* Lepel., *Xylothrips flavipes* Illiger, *Xylotrechus buqueti* Laporte & Gory and *Xystrocera globosa* Olivier as pests on living and stored khukan. In the present study, the insect pests damaging khukan in nursery and plantations at State Forest Research Institute, Chessa and Khellong Forest Division, Bhalukpong in Arunachal Predesh were collected, identified, studied and described as hereunder :

(a) **Borer**

1. *Auletobius gestroi* Faust (Coleoptera : Curculionidae) Fig. 1.

This is a dull-brown, 5 mm long weevil. It damages young saplings by forming a large number of punctures aronnd young shoots causing dropping off of the shoot-tips. This insect has been recorded as a serious pest of first year saplings of khukan at Chessa in Arunachal Pradesh during the years 1985-86.

(b) **Defoliators**

1. *Lepropus flavovittatus* (Pascoe) (Coleoptera : Curculionidae) Fig. 2.

This is a green coloured weevil which measures 16×6 mm in size. Its head is dark-brown with a broad greenish rostrum. The clubbed geniculate antennae arise from the distal end of the rostrum. The thorax remains covered with a large number of minute black dots dorsally. The elytron of the either side bears two bright light-pale longitudinal

stripes. The weevils of this species are recorded to defoliate the leaves of khukan and semul during June-July.

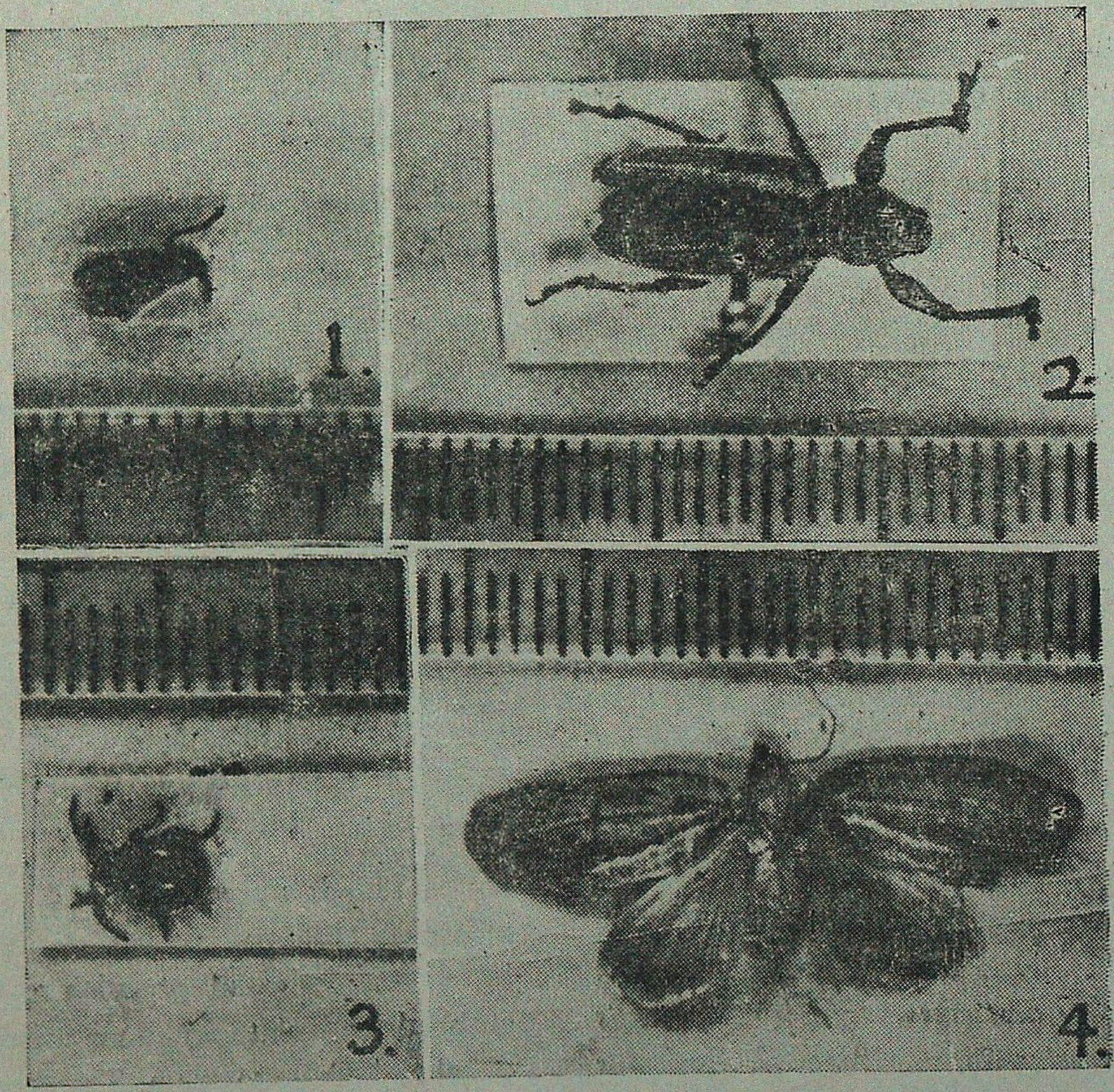
2. *Haltica cyanea* Web. (Coleoptera : Haltinae) Fig. 3.

This small steel-blue coloured beetle is recorded to defoliate the seedlings and trees in nursery and plantations during July-August in Khellong Forest Division, Bhalukpong (Arunachal Pradesh). It has also been reported to feed on *Terminalia myriocarpa* (Beeson, 1941).

3. *Selepa discigera* Wlk. (Lepidoptera : Noctuidae) Fig. 4.

The larvae of this insect defoliate the leaves of khukan completely leaving behind the harder mid-rib and side veins. They are about 16 mm long, hairy, yellow with a black spot on the 2nd, 7th, 8th and 9th abdominal segments. The moths are moderate with greyish-brown fore-wings. It has 5-6 generations in a year (Beeson, 1941).

Fig. 1–4



1. *Auletobius gestroi* Faust; 2. *Lepropus flavovittatus* (Pascoe)
3. *Haltica cyanea* Web. 4. *Selepa discigera* Wlk.

Acknowledgements

The author is thankful to Shri B.S. Beniwal, IFS, Divisional Forest Officer, Khellong Forest Division, Bhalukpong (Arunachal Pradesh) for necessary field help. Thanks are also due to the Director, Commonwealth Institute of Entomology, London, SW 5 for identification of the specimens.

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Regional Forest Research Centre,
Jabalpur (Madhya Pradesh).

K.C. Joshi

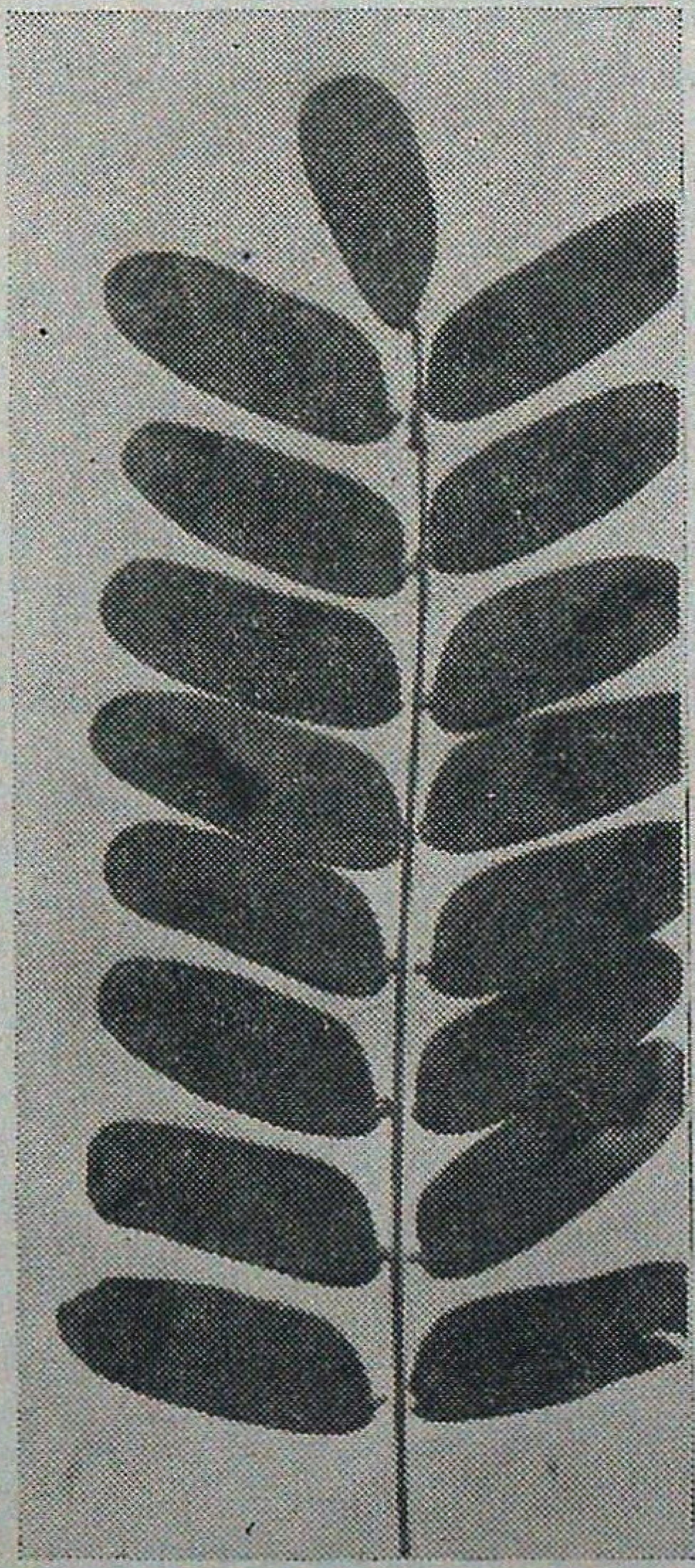
(II)

PLEIOCHAETA SETOSA—A NEW PATHOGEN OF *DELONIX REGIA*

During studies of the diseases in the north-eastern region, the authors encountered an interesting pathogenic fungus attacking the seedlings of *Delonix regia* (Bog. ex Hook.) Raf. in Social Forestry Nursery at Vasistha, Guwahati in 1986-87 which was identified as *Pleiochaeta setosa* (Kirchn) S. Hughes. The seeds were sown in the nursery twice first in the month of December and second time in mid March. In January the pathogen attacked the cotyledons which developed greyish black spots with depressed centre. The cotyledons shrivelled and died. The infected cotyledons were covered with sporulating structures of the fungus. No attack of the fungus was noticed on leaves which remained healthy. However, in April the pathogen not only attacked the cotyledons of the germinated seedlings but also the leaves of young seedlings causing dark brown spots. It also attacked the tender apical portion of the stem with leaves still in the initial stages of development and invariably killed it. The infection on leaves usually started from the leaf tip or margin and progressed rapidly covering a large leaf area. The infected portion shrivelled and dried and later turned brittle. It was invariably plastered with innumerable spores of the fungus which appeared dark-brown in mass. The infected leaves were shed prematurely. In no case the pathogen caused death of the seedlings. Even the seedlings attacked on the apical portion of the stem invariably put forth new side shoots and survived.

The fungus was isolated on PDA on which it sporulated poorly. The pathogenicity tests were conducted successfully both on cotyledons and leaves. Typical symptoms of the disease appeared on cotyledons in 5-7

Fig. 1



Infection spots on *Delonix regia* caused by *Pleiochaeta setosa*

days whereas on leaves they appeared in 8-10 days.

A laboratory bioassy of the fungicides revealed that Bavistin (0.1%) was most effective and it checked the growth of the fungus. Blitox (0.2%) suppressed 70% of the growth whereas Dithane-M45 was almost ineffective.

This is a new pathogen hitherto unrecorded in India.

State Forest Service
College-cum-Research Centre,
Burnihat (Assam).

M.D. Mehrotra*
G.S. Sarma
and
H.N. Dhungana

NEWS & NOTES

Seeds of *Bambusa arundinacea* 60 M.T. are available for sale. The interested parties may contact to the Divisional Forest Officer, Sironcha Division, Sironcha, Distt. Allapalli (Maharashtra).

MY EXPERIENCE

WHITE FLOWERED *ERYTHRINA* SPECIES

Sir,

On 19th March '88, I went on tour to Hamren Sub-division of Karbi Anglong District. There in the village More near Umpanai I came across about 3 flowering, unmistakably *Erythrina* trees. All the trees are bearing white flowers.

Umpanai is about 150 km from Guwahati at an altitude of 500 m. On return to Haflong, I went through all available literature and found no mention of white flowered *Erythrina*.

I have collected flowering specimens and took photographs of the flowering shoots. I have also took a branch cutting and planted at Divisional Cffice compound, which since sprouted.

I had first seen white flowered *Erythrina* during Feb '87 near Mahur in N.C. Hills. The tree was felled by Jhumiyas before I could collect specimens or photograph the tree.

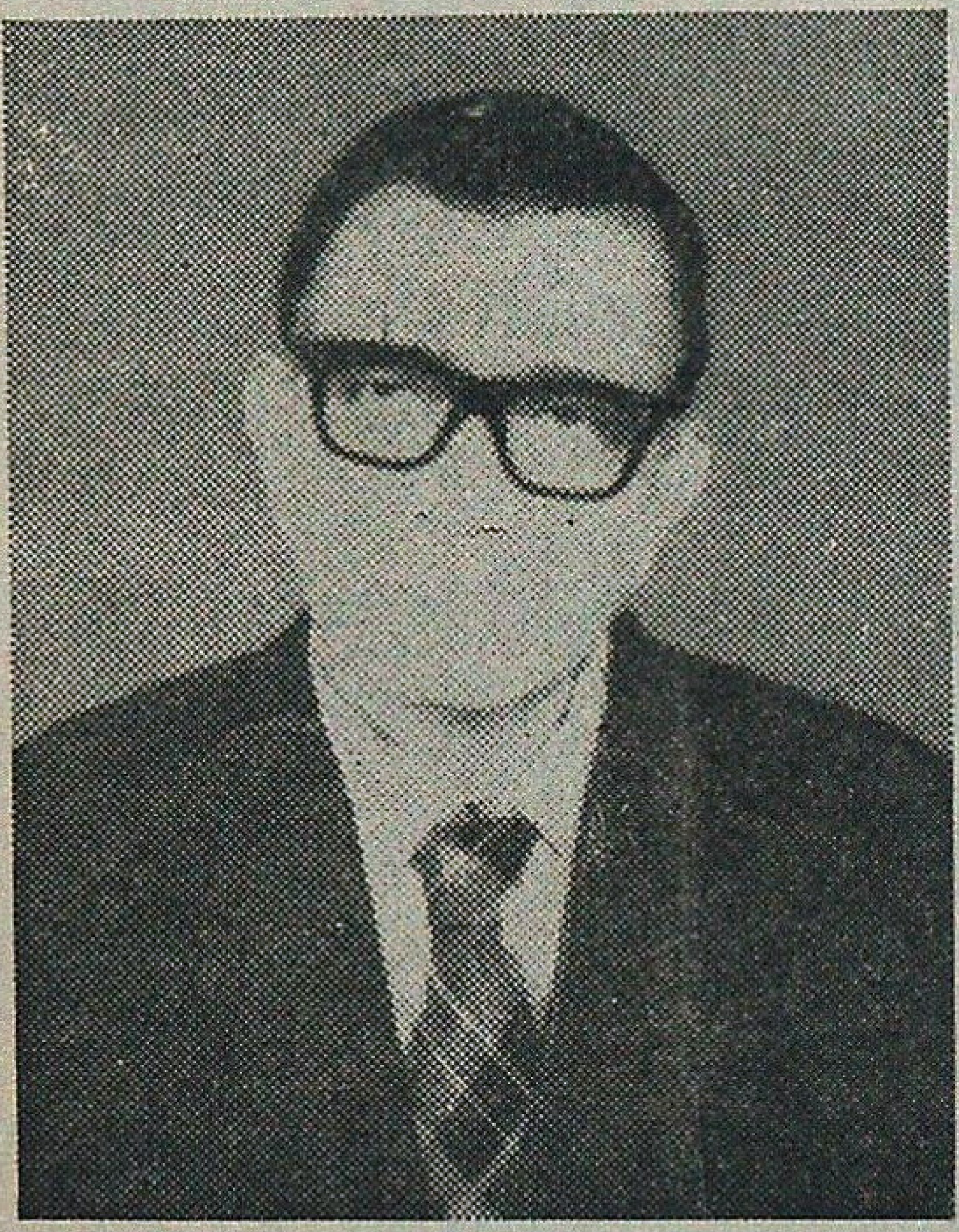
If I remember right, there was a mention of white *Erythrina* in Indian Forester sometimes in early Eighties but I could not locate it.

Yours Faithfully,
K.K. Gupta

Divisional Forest Officer,
Southern Afforestation Division,
N.C. Hills, Haflong (Assam)

OBITUARY

Padarbinda Mohapatra
(1926—1988)



Shri Padarbina Mohapatra, I.F.S., (Retd.) has breathed his last at Cuttack on 19th July, 1988 after prolonged illness. Born on 25th July, 1926 in Puri District, he had a brilliant academic career and had a fire of patriotism in his heart right in his youth. He had the distinction of leading the student agitation in December, 1946 and stood adamant in fluttering high the National Flag after lowering the Union Jack in Ravenshaw College, Cuttack where he was a student. After graduating in Science with Honours in Chemistry he joined the Orissa Forest Service in 1950. Subsequently he joined the I.F.S. in its initial constitution. He served in the Forest Department in various capacities and retired as Chief Conservator of Forests in 1984. He was a man of patience and perseverance, cool temper and endearing manner.s He wielded great influence over his staff as well as officers. He took active interest in building up of Nandankanan Biological Park, development of Social Forestry and Nationalisation of Sal Seed. He visited Japan in 1961 for a special training on Utilisation of Forest Products.

Retirement was not boredom for him as he devoted to journalism immediately thereafter. He was honorary General Manager of the oldest Oriya Daily "SAMAJ". He was very popular for writings on Wild Life in the Sunday edition of the Oriya daily. He was founder member of the Nature and Wild Life Conservation Society of Orissa.

He leaves behind his wife, two sons, two daughters, father, father-in-law, admirers, and whole society of foresters to mourn the loss.

May God grant the departed soul ever lasting bliss.

—Asstt. C.C.F. Orissa

GAZETTE NOTIFICATIONS

ANDHRA PRADESH GAZETTE

The following postings of Project Directors, District Rural Development Agencies are ordered :—

1. Shri M. Subrahmanyam, Deputy Collector, whose services are placed at the disposal of Panchati Raj and Rural Development Department in the notification read above is appointed on deputation under foreign service terms as Project Director, District Rural Development Agency, West Godavar i District, Eluru vice Shri G. Seetharama Rao, Deputy Director of Agriculture surrendered to his parent Department, i.e., Food and Agriculture Department.

2. Shri P. Madhusudhana Rao, IFS., State Silviculturist, Cuddapah is taken on deputation under foreign service terms and appointed as Project Director, District Rural Development Agency, Adilabad in the existing vacancy.

KARNATAKA GAZETTE

On repatriation from Government of India Dr. S.N. Rai, IFS., Conservator of Forests is appointed with immediate effect and until further orders as Conservator of Forests, Canara Circle, Dharwad vice Shri A.N. Yellappa Reddy, IFS., transferred.

Shri A.N. Yellappa Reddy, IFS., Conservator of Forests, Canara Circle, Dharwad is appointed with immediate effect and until further orders as Conservator of Forests, Research & Untilisation, Bangalore vice Shri K.A. Kushalappa, IFS. transferred.

Shri A.S. Sadashivaiah, IFS., Conservator of Forests, Mysore Circle, Mysore is appointed with immediate effect and until further orders as Conservator of Forests, Shimoga Circle, Shimoga vice Shri A.C. Lakshaman, IFS., transferred.

Shri A C Lakshman, IFS., Conservator of Forests, Shimoga Circle Shimoga is appointed with immediate effect and until further orders as Conservator of Forests, Bellary Circle, Bellary vice Shri A.S. Kumar, IFS., proceeded on leave.

Shri K.A. Kushalappa, IFS., Conservator of Forests, Research & Utilisation, Bangalore is appointed with immediate effect and until further orders as Conservator of Forests, Mysore Circle, Mysore vice Shri A.S. Sadashivaiah, IFS., transferred.

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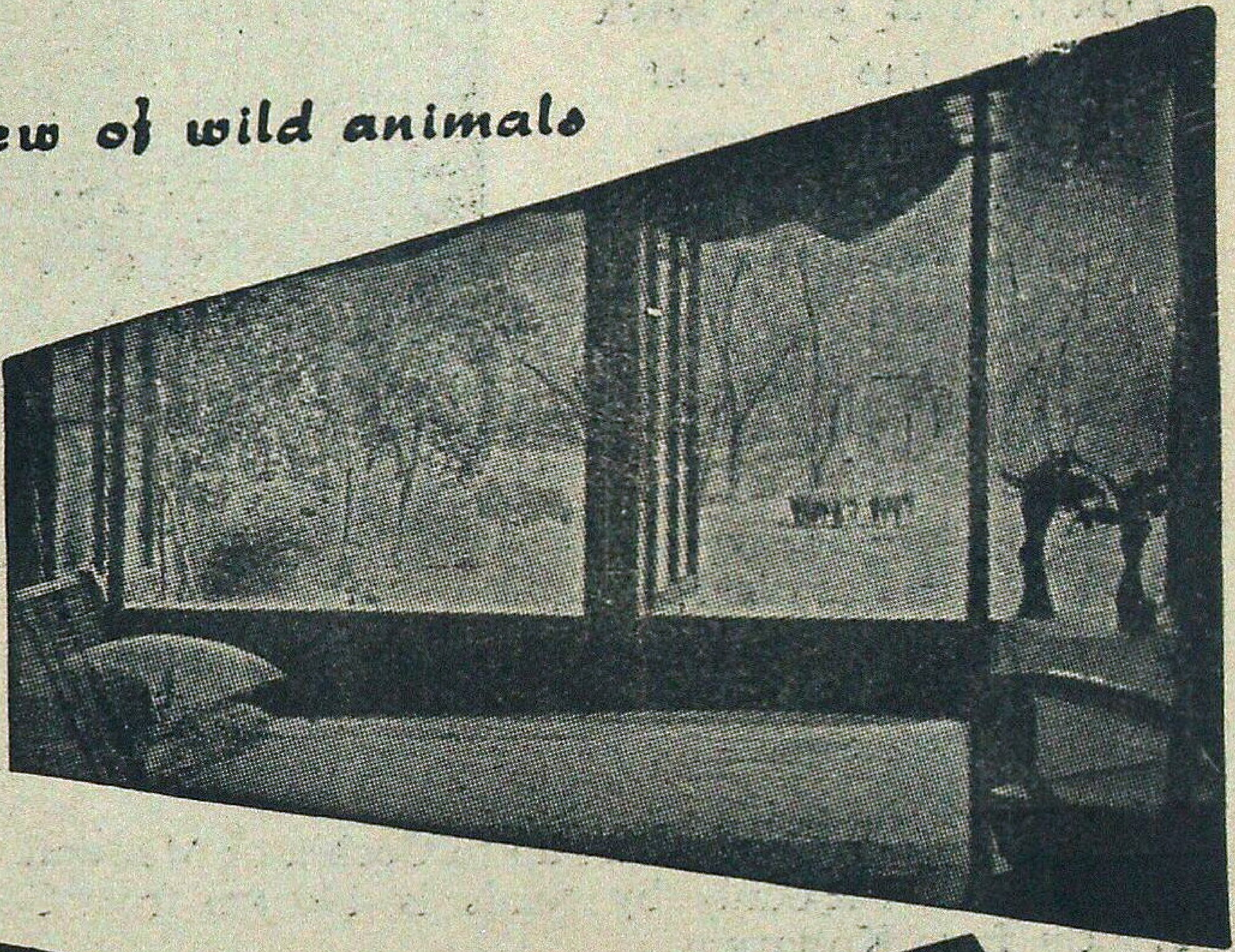

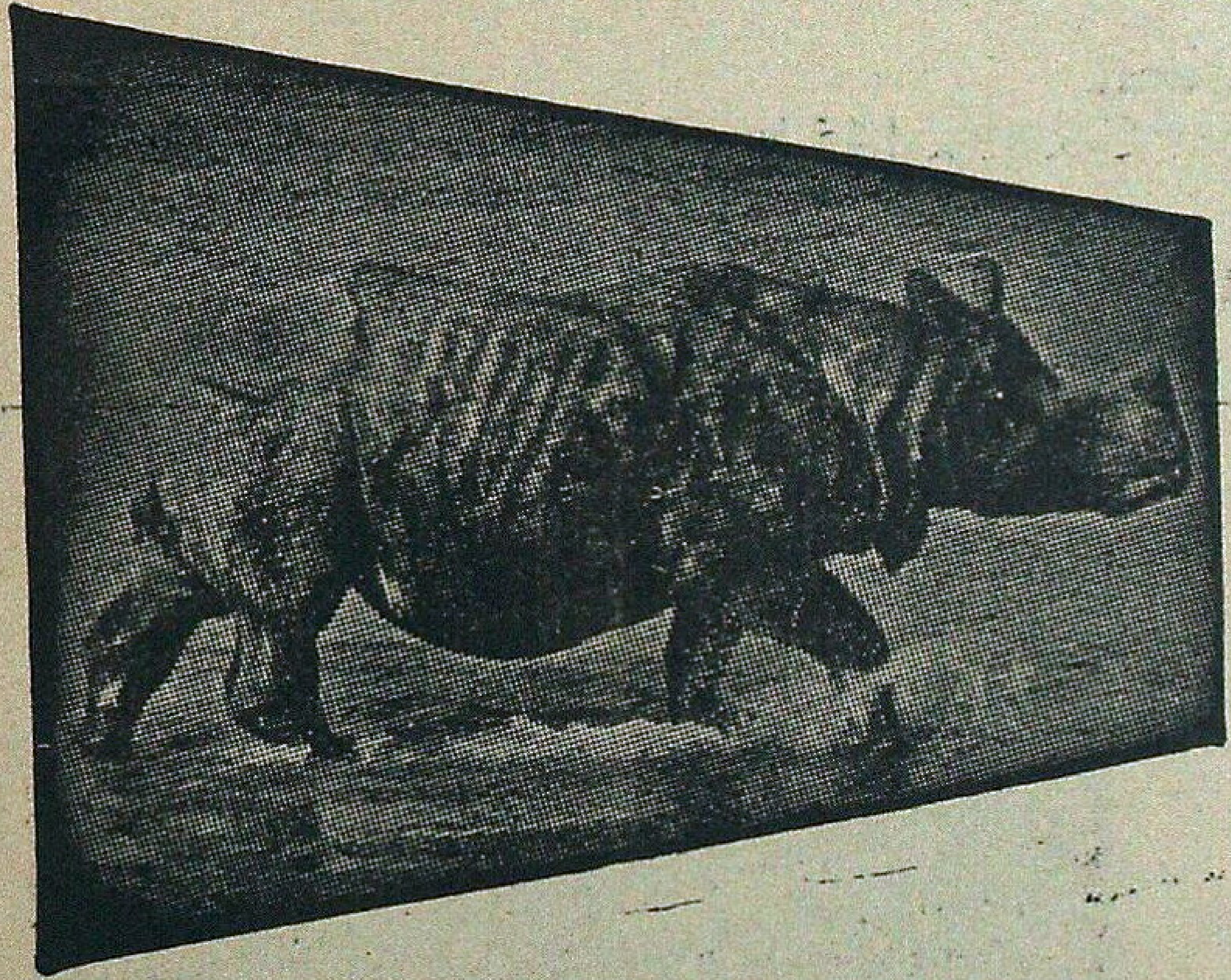

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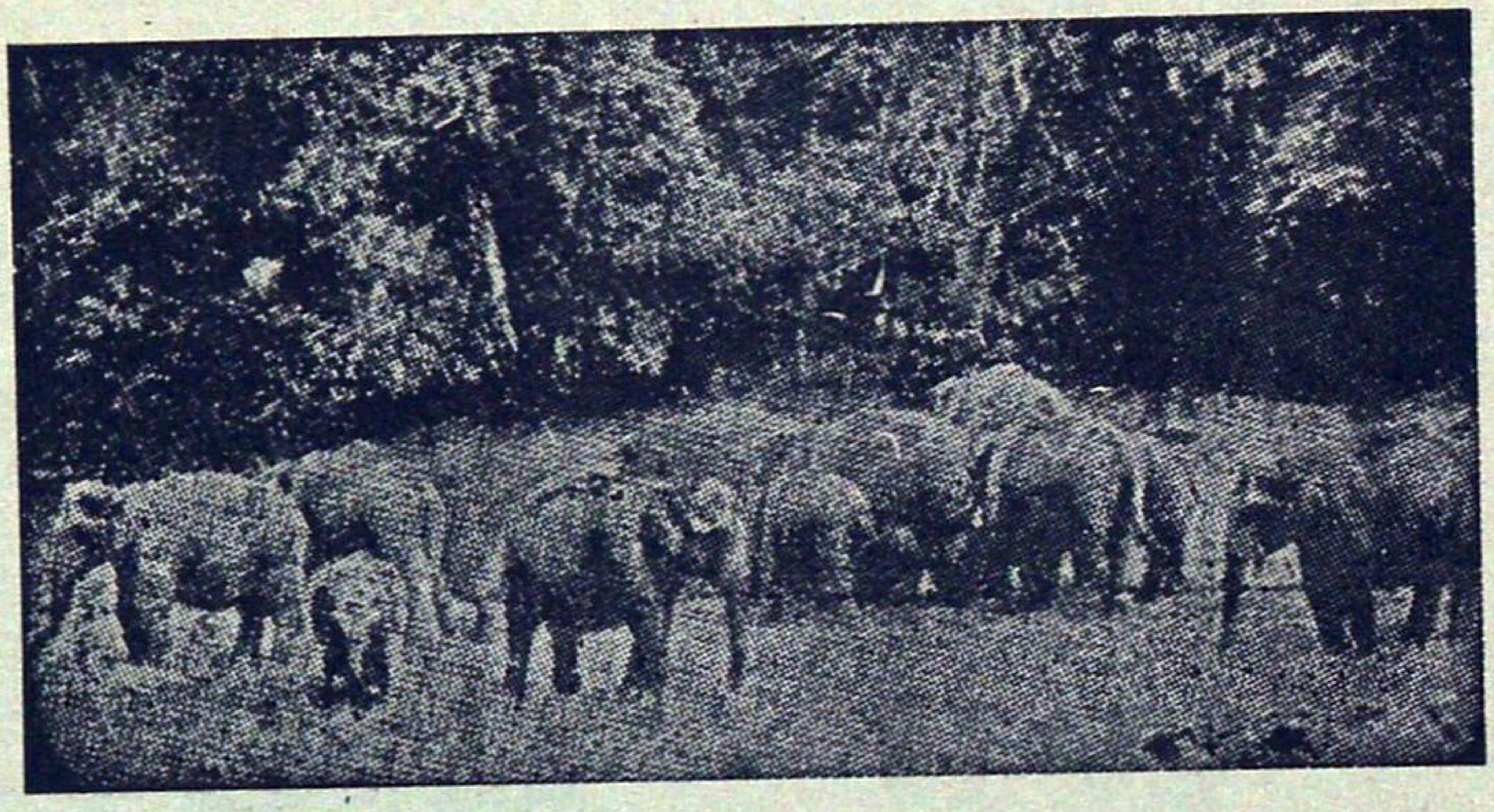

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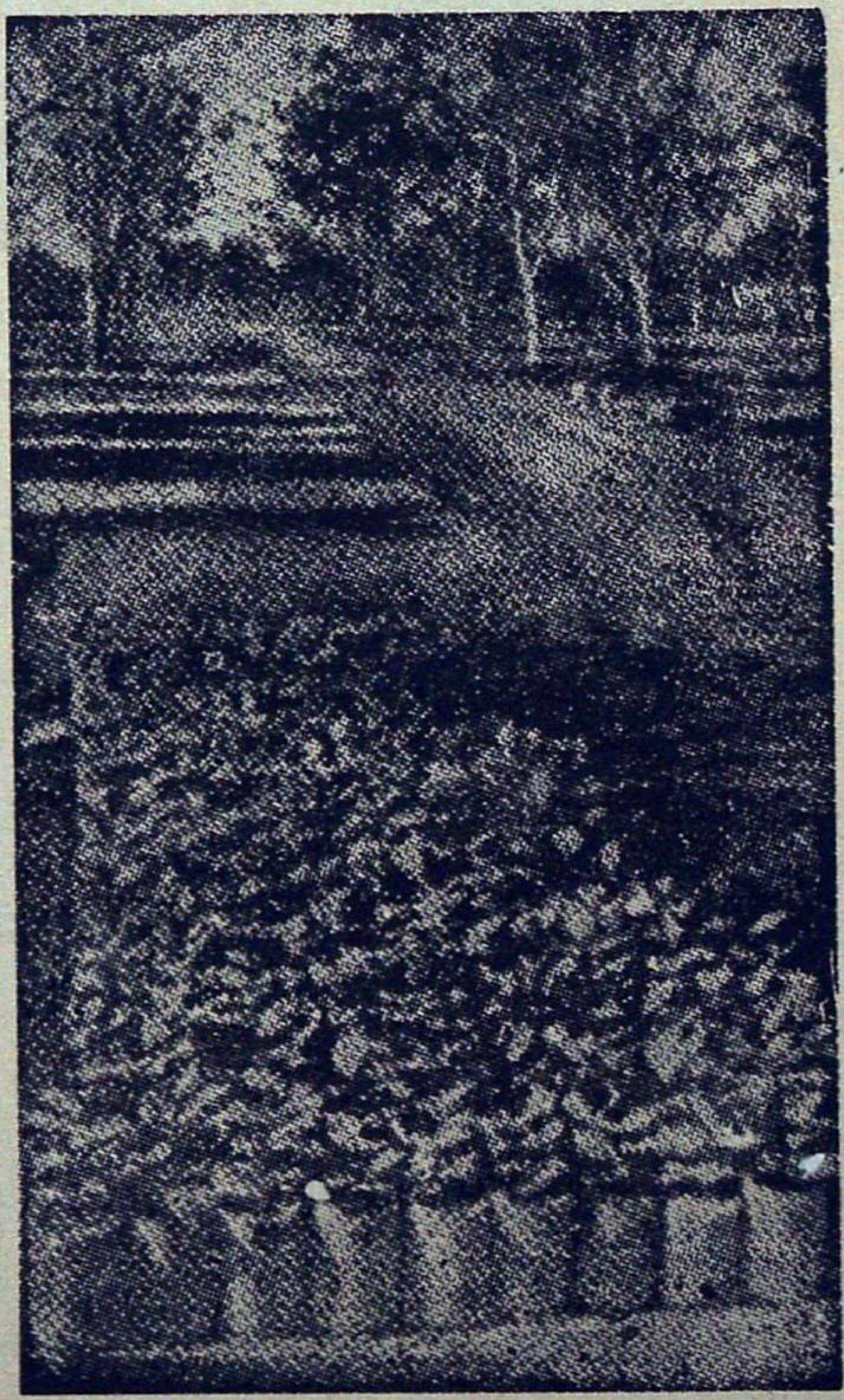

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(A Govt. of Arunachal Pradesh Undertaking)

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SHIMLA

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Himachal Pradesh State Forest Corporation has taken long strides under the benevolent guidance of our Chairman Prof. Chander Kumar, Hon'ble Minister of State for Forests.

* With complete nationalisation of forest working viz; timber operations, resin tapping etc. both in Govt. and private forests, there is complete elimination of contractor' agency. Modernisation of timber operations has reduced conversion wastage considerably and the incidence of organized illicit felling in forests is completely under control.

* To ensure gradual reduction in use of valuable coniferous timber for packing cases, effective steps have been taken for distribution of Card Board Cartons and purchase of Wooden Packing Cases from adjoining States of Punjab and Haryana.

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c) Providing incentives to officers and staff through prompt action on service matters like confirmations, job rotation vis-to-vis career planning including specialized training.

(V.P. Mohan)
Managing Director.

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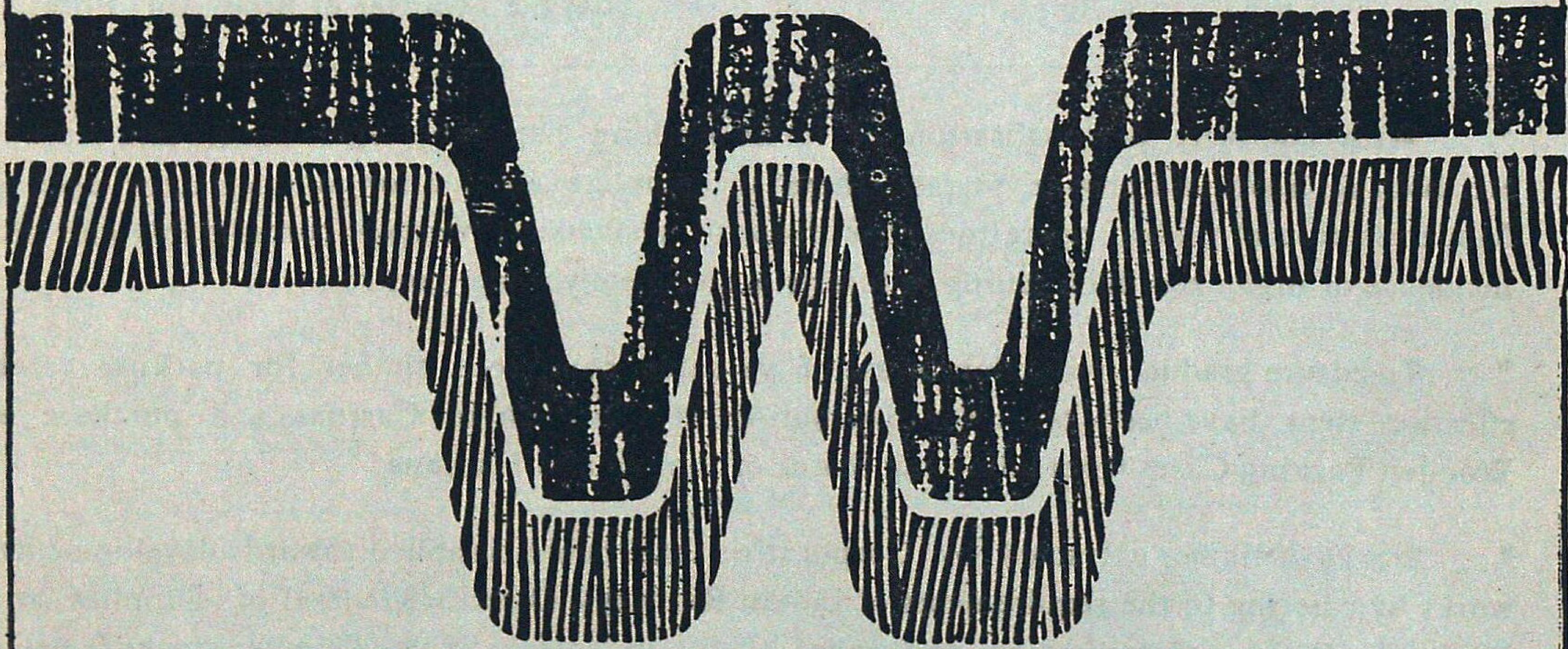

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Forests conserve Soil and Water besides ameliorating environment. Plantation targets from all sources stand at about two lakh hectares including Wasteland Development Progamme. People's participation in afforestation programme is encouraged through Social Forestry which covers the whole State. M.P. Forests are a great source of non-tax revenue. They generate eight-crore man-days of annual employment. Forestry-activities provide jobs to weaker sections of society in lean season.

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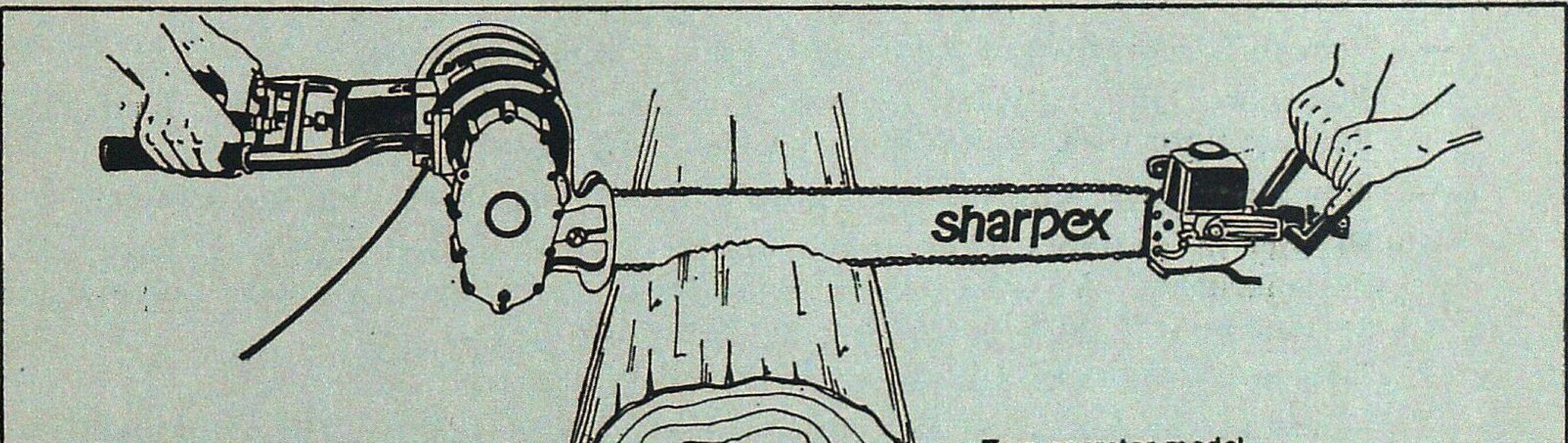
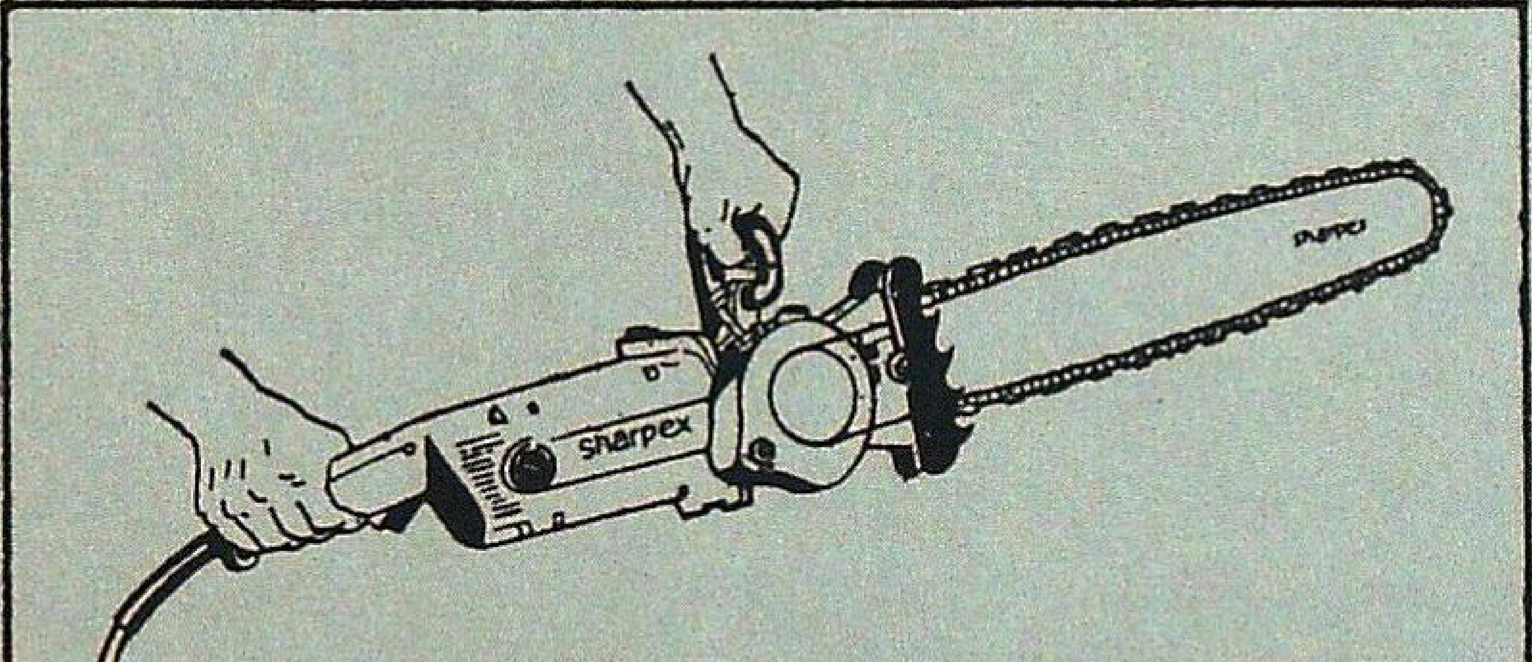
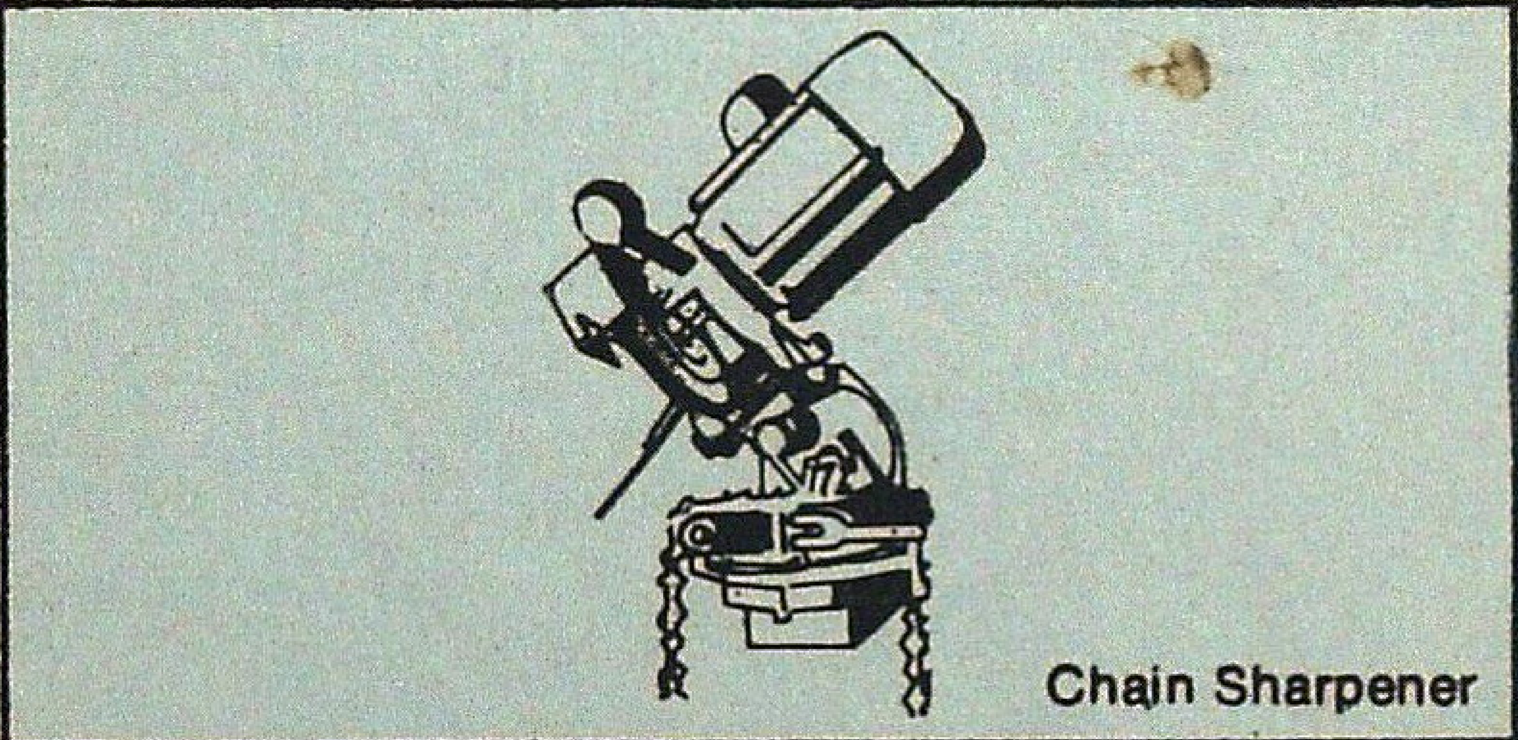


Two operator model



Single operator model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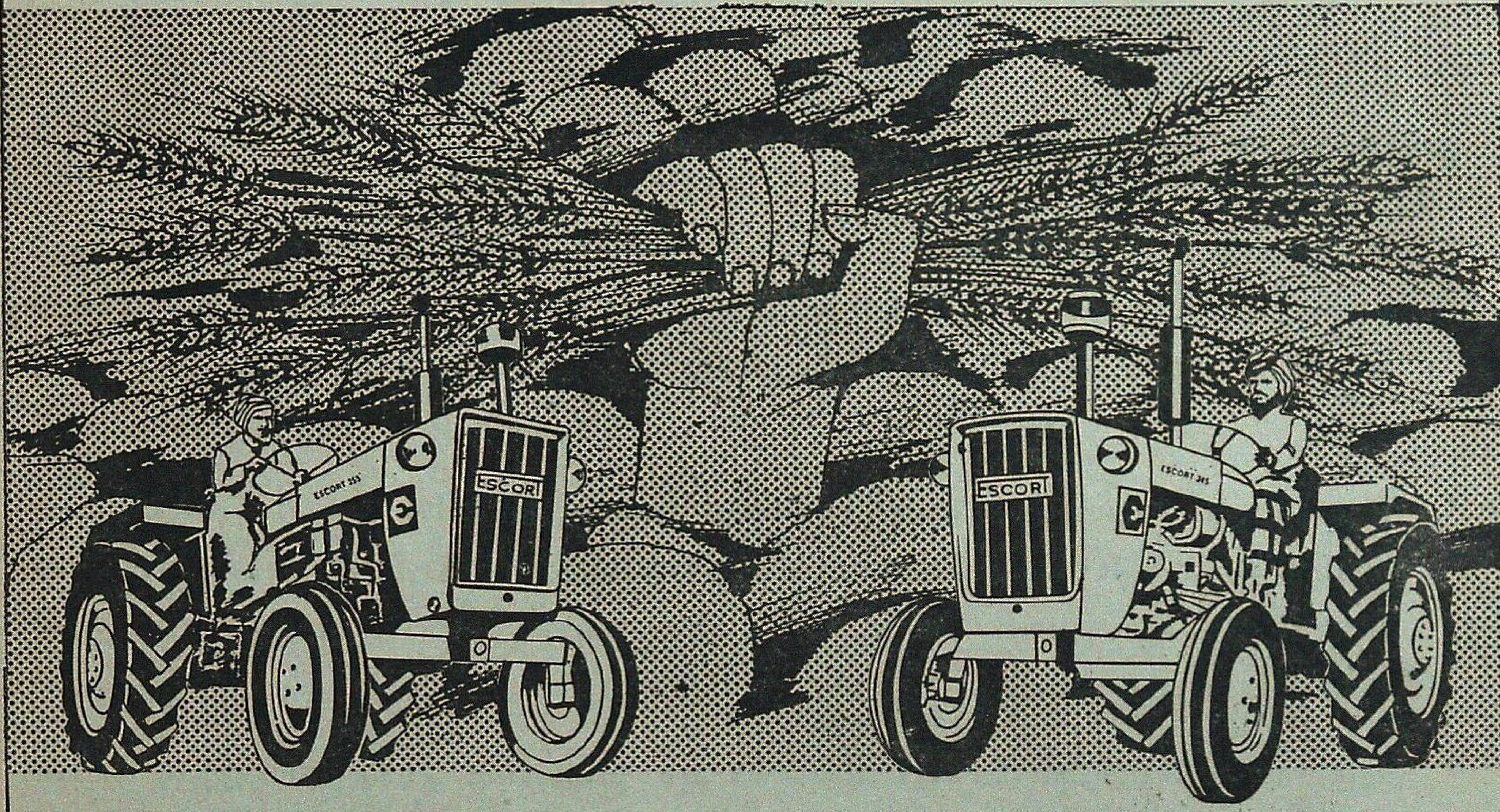

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Mizoram Forests Through The Years

During the British period i.e. from 1890 till the year 1952, the management of Inner Line Reserved Forests was done under the supervision of Superintendent of District. The District was put under 'Excluded Area' and practically no Statutory Act or Law were enforced to manage the Forests. Practically nothing had been done. The Inner Line Reserved Forests was constituted under the Assam Forest Regulation comprising an area of 559 sq. kms.

When the Mizo District Council came into being in 1952, the management of all the Forest other than the State Inner Line Reserved Forests was handled by the District Council. Thence the District Council started to make its own Forest Wing. Under the District Council one Forest Division called Aizawl Forest Division was created comprising the then whole area with headquarters at Aizawl. In fact during the time of the then District Council, most accessible areas of the forests had been overtapped for earning more revenue and due to population pressures.

In the early 1960's the first plantations were raised by the District Council in different centres. During the year 1966—1968, practically no plantation could be raised due to political disturbance in the Mizo District.

After Mizoram became a Union Territory in the year 1972, the Union Territory Government formed one more Forest Division with headquarters at Lunglei.

The present position of Mizoram Forest Department may be summed up as follows :

The Mizoram Forest Department is headed by the Chief Conservator of Forests. The field work has been taken up with ten (10) Territorial Divisions. In addition to this, six (6) Functional Divisions have been set up. There are now three (3) Circles namely—Southern Circle, Northern Circle and Research & Development Circle. The Government of Mizoram has already constituted three Wildlife Sanctuaries in order to preserve its vanishing Wildlife. Four more Wildlife Sanctuaries are being proposed which are likely to be constituted very soon. The Mizoram Forest Department has created 1,00,029 hectares of plantation upto 1987 as against 967 hactares before it attained U.T. Status.

Issued by :
CHIEF CONSERVATOR OF FORESTS,
MIZORAM : AIZAWL.

KARNATAK STATE FOREST INDUSTRIES CORPORATION USHERS IN THE PROGRESSIVE ERA FOR FOREST PRODUCE !

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Soon, KSFIC will diversify to market Flush doors and Block Boards from its manufacturing unit at Bangalore. It also has plans of marketing pulverised sandalwood powder from sandalwood white chips and spent wood in the immediate future.

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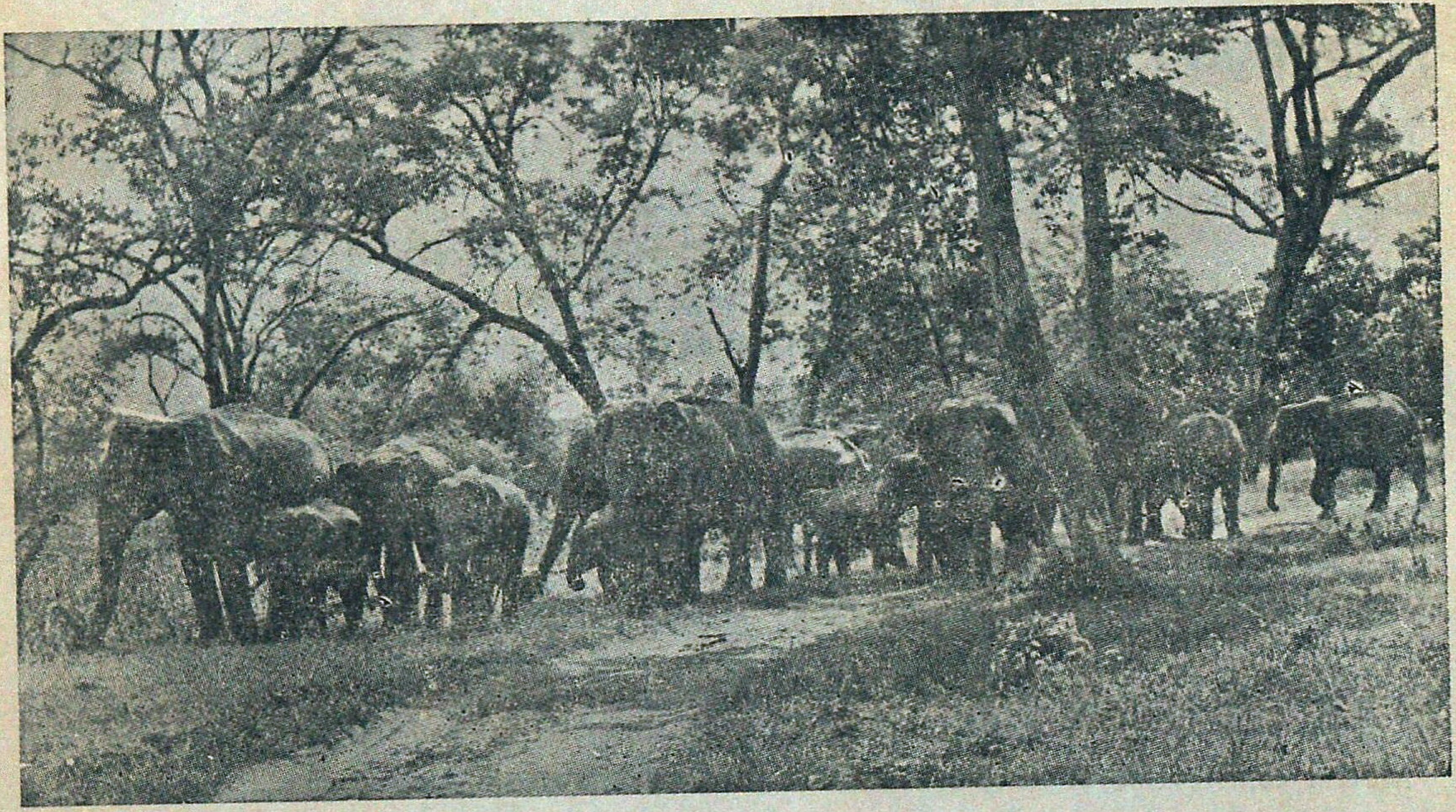
With Best Wishes.

(R.S. Mishra)
Managing Director.

BANDIPUR TIGER RESERVE

KARNATAKA



Lovers of nature and Wildlife the world over find it well worth their while to linger on in Bandipur. More famous as a Tiger Reserve, Bandipur enjoys reputation as a wildlife sanctuary that stretches as far back as 1931. The Mysore Maharajas; benign rulers and farsighted visionaries understood the compelling necessity of protecting the fauna, avifauna and flora from the thoughtless foreys of marauders. Today 874 sq kms. of the Bandipur National Park makes up the Tiger Reserve which is one of India's finest parks.

But Tigers, native to the country and the most magnificent of the great cats are saved from threatened extinction. An abundant variety of fauna: the panther, wilddog, Sloth bear, Sambar, Chital, barking deer, fourhorned antelope, common langur; avifauna like peacock, grey jungle fowl, crested hawk, eagle and reptiles such as crocodiles, Python, Vipers, etc., roam this park freely.

Hundreds of spotted deer greet the visitors right at Bandipur campus, at night times as they step out of comfortable cottages.

A herd of elephant majestically moving single file through a patch in the jungle can be viewed on an elephant ride. If one is lucky he can watch in absolute silence, of course—a herd of Indian 'bison' or gaur, locking horns a few meters away.

Nature at its bountiful best- Bandipur bestows the soothing solace of jungle retreat off the beaten track and far from the madding crowd.

For further particulars, please contact

The Field Director
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Government House Complex
MYSORE 570 010
(Karnataka—State) India
Telephone No 20901

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THE

INDIAN FORESTER

VOLUME 114 AUGUST, 1988 NUMBER 8

WATER HARVESTING IN NATURAL 'SHOLA' FOREST OF NILGIRIS. Front Cover
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